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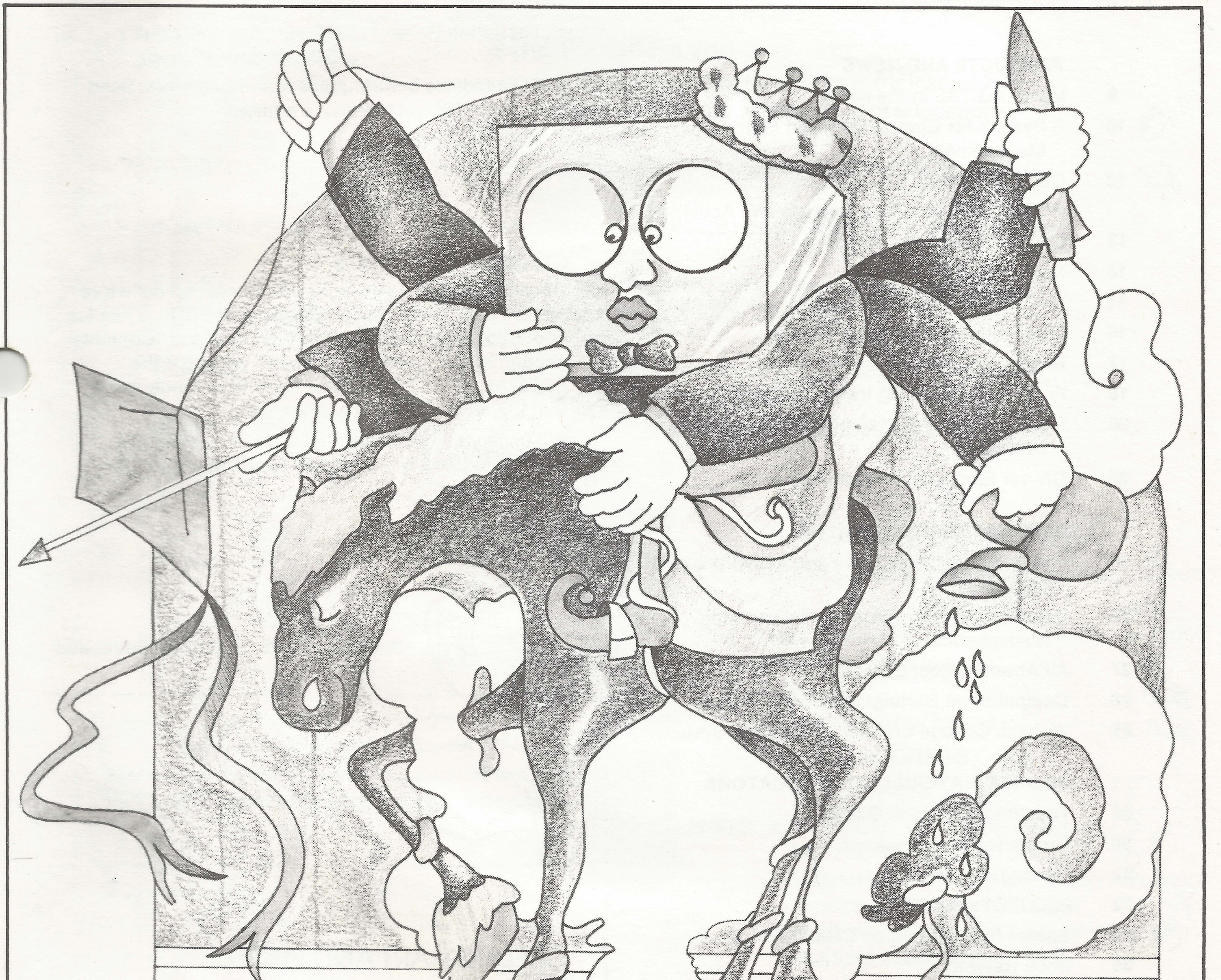
Spring 1974



THIS ISSUE OF EDU FEATURES GAMES AND SIMULATIONS:

APPLICATIONS, RESOURCES, ACTIVITIES FOR LEARNING

THIS ISSUE OF EDU FEATURES GAMES AND SIMULATIONS

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PUBLISHER'S STATEMENT

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CODED CONTENTS

Because we know how busy educators can be, we've started something new in this issue of EDU . . . just for you! See those strange little symbols in the "Contents" section? Decode them, and they'll point out the SPECIAL INTEREST articles for you. No code means that the article is of general interest.

We hope you'll have time, soon, to read all of EDU. But just in case, don't miss the parts that we think you'll like best!

🍎 = Primary and Secondary Education

🎓 = Higher Education

CREDITS—ART AND PHOTO

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SPEAK OUT (Contributions, Opinion and Letters to the Editor)

CONTRIBUTIONS

We know how hard it is to take the time to send your contributions to EDU. Especially now, when you're busy preparing courses for this term or school year! But EDU *needs* input from its readership . . . Do EDU and your fellow educators a favor. Make a resolution to write at least one letter to EDU this year . . . Okay? Talk about anything . . . your installation, your computer instructional programs or your ideas . . . for all levels of instruction from grade school to college and university. Typed or hand-written materials will be accepted—send us edited or unedited material. And if you need some ideas, look at our back issues of EDU, or write something for the following categories:

SPEAK OUT (Contributions, Opinion and Letters to the Editor)

PRODUCTS AND NEWS (Book reviews, classroom aids, other people's products, anything new for classroom computing).

APPLICATION BRIEFS (Stories about your installation, applications at any level).

SOURCE MATERIAL FOR EDUCATORS (Books, papers, articles, ideas and materials).

CONFERENCES AND REPORTS (Meetings of interest, articles, reports and stories [original or borrowed!]).

IDEAS AT WORK (Classroom ideas, hints for teaching).

Send your letter, article and/or materials to EDU, Editor, Education Products Group, 5-5, DIGITAL.

CORRECTION: "A Small Memory Yields A Large One," which appeared in EDU #9, p. 11, contained an error. Dr. Francis Wheeler's DRILL program requires only 4K of memory, not 12K. (Imagine only 4K!) Our sincere apologies for the error.

WANTED: FULL COLLEGE PROFESSOR

We are looking for an American professor to teach 2 years in Cologne, Germany. Government paid. Candidate must have programming experience; PDP-11 DOS preferred.

If interested, send resume to Paedagogische Hochschule, Rheinland, Cologne, Germany.

CLASSIFIEDS

READERS: This is *your* section. We'll run your ad here FREE if you're a school or non-profit organization. Got some older equipment you'd like to sell, a useful software package, or some other service? We'll also run want ads—looking for hardware, software, part-time labor, etc.?

Dear EduPerson:

Will you please print this plea for materials? Our Science Department recently started using the new Intermediate Science Curriculum Study (ISCS) from Florida State University. Much to our chagrin, these materials did not include any computer-related problems or simulations.

PLEA: Have any of you prepared any materials on your system to be used with these science materials? If so, please write us, let's set up an information swap.

LeRoy Finkel, Ravenswood High School, 2050 Cooley Avenue, East Palo Alto, CA 94303.

OPINION: WHAT'S WRONG WITH THE LITTLE RED SCHOOL HOUSE?

by David H. Ahl

I have a couple of observations on education and learning:

1. Kids learn best from other kids, probably outside of school. Some of the best learning probably occurs in the street!
2. Although textbooks are written by the best minds and are cram full of enlightened information of allegedly great worth and importance, they never get stolen.
3. Kids spend a fantastic amount of time in front of the boob tube. Indeed, at the time of entering first grade, the average child has spent more time with the TV than with both of his parents.
4. Motivation is much more important than teaching method or style of delivery.
5. Kids don't respect people who talk down to them, try to use their slang without knowing what it means or who are in any way artificial or self-important.
6. Kids' minds are unencumbered by constraints of what can and can't be done. Kids will try just about anything.
7. Learning by discovery, doing, or manipulating sticks with you far better than learning by reading about.
8. Learning to learn is infinitely more important than learning facts and data.
9. Isaac Asimov, Herbert Simon, Marshall McLuhan, and Herman Kahn will have more impact on the future than all the textbooks in print.
10. Computers are the most powerful tool man has ever invented and the most awesome responsibility he has ever faced.
11. Education has become relatively less efficient than practically any other aspect of our economic or social development.

What does all this mean? In short, it means that the little red schoolhouse which we hold so dear to our hearts is no longer satisfactory. Not only just unsatisfactory, but in urgent need of change. No longer can we rely upon the teaching approaches of yesterday; in fact, we can't even rely upon the ones of today. Half of the piecemeal, one-at-a-time changes we're making in the educational process are out of date before they're even implemented widely.

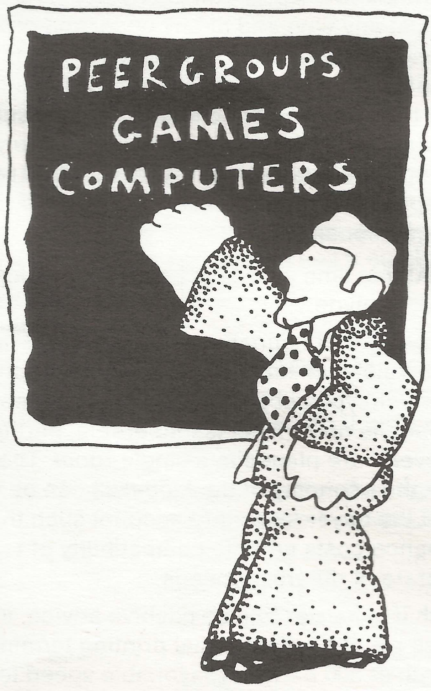
Compounding the slowness of educational innovation is the fact that many of the new systems introduced over the last 20 years using the latest technology have fallen flat on their faces. This is true of things like teaching machines, drill-and-practice CAI, language labs, closed-circuit TV, and perhaps now even the "new math." These shortcomings and failures have given the traditionalists all kinds of ammunition to shoot down other new things on the horizon and, indeed, have imbued nearly every educator with a hearty skepticism for educational technology.

Those educators who have revolted against drill-and-practice PI and CAI believe that getting a pile of data into a kid's head is not as important as teaching underlying structure and modes of self-learning. Challenging and stimulating students, and then providing them with an information-rich environment in which they can seek their own solutions, is seen as a better way to teach. On the other hand, opponents of these new ideas fear that free-form education will result in gaps in the basic knowledge considered essential in conventional education.

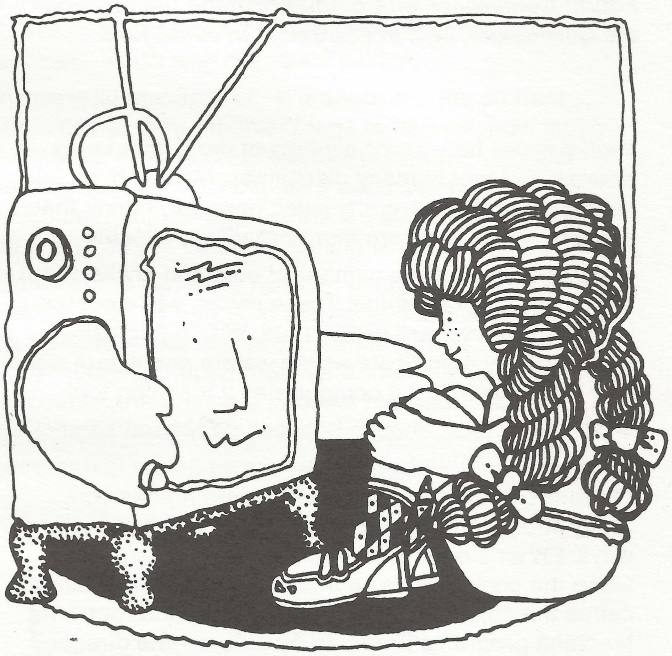
Objectives must be broadly stated and must not only be relevant to the world of today but to the world of the future. Knowledge is changing and advancing so rapidly that we must expect objectives to change, or conversely, be formulated in a broad enough fashion to keep up with technological advances. The Maeger-style behavioral objectives don't begin to meet the need. Education today needs more than small behavioral steps. It needs objectives that are dynamic and can be expected to change over time; objectives that are stated in an entirely new way.

Objectives must be devised to lead young minds through an imaginative exploration of the jungle of political, social, psychological, and ethical issues that will confront them as adults. What is the objective which will foster decision-making ability under uncertainty? What are the objectives which elucidate the ways in which technology and values will interact in the world of tomorrow? How does one measure whether one has learned to learn? I'm not saying these objectives are impossible to devise. Indeed, these are the kinds of things that education must focus on, and these are the objectives that must be devised.

And while educational objectives must change and grow, so must its methods. One-third of the observations stated at the outset say, in one way or another, that the medium really is the message. Today, learning to read from a book can be substantially enhanced with the "Electric Company" on TV and with Moore's Talking Typewriter. For some aspects of education today the book is hardly an acceptable alternative at all; yet for other aspects, it's still the best approach.



Determining who is right and who is wrong is probably not very productive, although many researchers are engaged in that happy pursuit. More to the point, when one looks more deeply, it's not clear that all the technological innovations did fail. Some of them undoubtedly did. However, what's much more evident is that we probably don't know how to measure the results. Or going one step deeper, it's not at all clear that we have even established meaningful objectives.



For example, learning to fly an airplane is best done on a flight simulator. Learning to create a movie is best done by actually creating one. Learning about political action is best done by observing and participating. Learning about resource management and resource utilization is best done by manipulating computer simulation models. Learning a logical approach to problem solving is best done by breaking a real problem down into manageable pieces, flowcharting it, and programming it for a computer. Learning an appreciation for literature is best done by reading books.

So, in addition to broad, dynamic objectives, education also needs some new methods. Not one to the exclusion of others, but a whole potpourri of techniques. Things like peer teaching, computer games and simulations, free learning environments and piles of motivation. Motivation is strongest when it comes from real involvement and genuine accomplishment. We have to let kids work with real tools on real problems, not a bunch of contrived textbook situations. We have to give kids tools far more powerful than we think they can possibly use. The results will be unbelievable!

OPINION: The Computer in Teaching: Ten Widely Believed Myths

by Alfred M. Bork
Physics Computer Development Project
University of California at Irvine

The following remarks were made by the author at the SIGUCC meeting which followed immediately upon the Fourth Conference on Computers in the Undergraduate Curriculum, held in Claremont in June, 1973.

I will discuss here some aspects of the computer as an educational tool in many disciplines. My teaching field is physics at the university level; however, I think that many of my findings are more broadly applicable.

My plan is to review a number of common myths about the computer in teaching. These myths, while not universally believed, are widely held. Within this framework I will try to indicate where we are and where we may be going with the computer as a teaching tool.

Myth 1: You must choose between direct and adjunct use of the computer.

Literature about the computer in learning has correctly stressed that the computer can be used in two ways. Either students can do their own programming, using the computer as an intellectual tool—sometimes called the adjunct use—or students can interact with teaching programs prepared by others—the direct or mainline use. However, much literature tends to go beyond this, stating or implying that a *choice* must be made between these two. During the past three years some major developments in educational computing have chosen between the two uses, making it difficult, either because of equipment or socio-political factors, to engage in the other approach. I see absolutely no reason why a teacher should be obliged to make this choice. Satisfactory examples exist of the computer being used both ways, and so neither need be ruled out on philosophical grounds. The same can be said about the many types of dialogs, interactions between teacher and student via the computer. Probably certain types will prove to be efficient for particular subject matter areas, whereas other subject matter areas may require different kinds of dialogs.

Myth 2: You must have massive equipment to use the computer in education.

Some of the more interesting teaching applications have come from schools with minimal computer equipment. Small stand-alone minis certainly do rule out some of the kinds of things that can be done. Thus, dialogs are not possible on small minis; but many other types of usage are possible. The idea persists that one can start only at the level of huge installations, but innovative teachers have shown it to be wrong many times.

Myth 3: One language is much easier to learn than another.

When students write programs for problems in physics or mathematics courses, the questions of which language to use and how students learn that language become important. Arguments are often based on supposed easy learning of one language or another; thus proponents of BASIC often claim that it is very easy to learn. My own experience indicates that the way the language is taught is much more important than the language itself in determining speed of initial learning. If a reasonable subset is picked, and if reasonable ways are used to introduce the language to students, almost all commonly used languages are relatively easy for beginning students to learn and to use. In my opinion, differences between initial learning ease have been much exaggerated.

Myth 4: Computers will be widely used in education in *present* organizational structures of institutions.

New educational developments are often assumed to fit into existing institutional structures. However, it appears to me that the computer is almost certain, in the long run, to revolutionize the organization of schools and universities. The ability to provide learning materials at any time and at any pace, and provide self-testing features, the ability to respond individually to students, to have access to large amounts of data, all imply that the way schools operate are likely to change drastically when computers are widely used in learning. One interesting view of how this revolution might happen is presented in *Education and Ecstasy,* by George Leonard.

Myth 5: At this time your best buy for a terminal is the Model 33 Teletype.

I feel strongly that educational users should *never* buy Model 33 Teletypes today! This is an old, unpleasant device which types at a slower speed than most students read. Its noise level is intolerable, particularly when several are placed in a single room. The argument for the economy of the Model 33 can be challenged if the buyer takes into account such things as maintenance costs and the compatibility of terminals that operate at different speeds.

Although it is harder to give positive advice, in our own case we like both thermal printing terminals (which run at 300 baud, a reasonable speed for reading, and are pleasant and relatively easy to maintain), and the graphic terminals, which have the same advantages plus the very valuable capacity for drawing pictures under computer control. I believe that the future for almost all educational use lies with graphics.

Myth 6: Computers are too expensive to use in teaching.

This issue is one of bookkeeping. With any new technology it is hard to know how to calculate costs, and computer centers in practice do this in quite different ways. (For example, existing time-sharing systems quote a wide variety of prices, from $.25/hour to $50/hour.) Furthermore, it is hard to make comparisons with the costs of other components of education, since these often reflect very different types of bookkeeping. It has been claimed, for example, that it costs more than $10 each time a book is checked out of a library. Clearly if we regarded this as a direct cost of education, libraries might be considered too expensive, yet almost no institution takes that attitude today. I think that computers are probably now competitive with other teaching methods, but this is difficult to demostrate.

Regardless of what one thinks about the costs today, the *future* situation is clear: of all the costs involved in the educational process, computer costs are almost the only ones going down. Teachers, books, buildings, and films are going up in cost, while computer costs, because of a rising curve of technological development, are still diminishing dramatically; so the computer will become more and more competitive as a teaching device over the next few years.

Myth 7: If we acquire a CAI language, that solves our problems.

Many computer center directors take the approach that if some language is *available* (i.e., on the computer in an operational form) for assisting teachers in developing student-computer dialogs, they have discharged their duties to the teaching community. At one time COURSEWRITER was highly promoted in this way. Today PLANIT and TUTOR tend to be the ones that are advertised as available.

Experience in many teaching applications shows, however, that the availability of a dialog language, no matter how good the language may be, is only a small part of the process of getting reliable and educationally useful teaching materials on the computer. The whole problem of an *authoring* system—the way one persuades teachers to write materials, the full facilities provided, the incentives for doing this, the use of secretaries, programmers, and other kinds of auxiliary people, the testing procedures, the gathering of feedback, and the preparation of suitable computer-related text material—is enormously more important than the question of the language itself.

Myth 8: PLATO and MITRE are solving all the problems.

The two large-scale projects now using the computer for learning, with massive government support, are PLATO at the University of Illinois, and the MITRE Corporation project with courseware centered at Brigham Young University. Both are very interesting projects. To regard them as exhausting all the possibilities, however, is quite wrong. Many interesting teaching materials that exist today could not be run on either of these systems. I think it would be unfortunate if the success or failure of these two large projects dictated all further educational use of the computer. In this regard I agree completely with Arthur Leuhrmann's evaluation of these two projects at the 1972 Spring Joint Computer Conference. (See *SIGCUE Bulletin,* Vol. 6, No. 4, October 1972; pp. 9-11.—Ed.) We need a thousand flowers, not just a few! So I hope that we will not all jump onto the large projects' bandwagons.

Myth 9: Valid educational material can be developed without involving experienced teachers in the area.

Teaching is still teaching whether done by computer or by any other device. My experience shows that really effective educational materials are still coming, in spite of talk to the contrary, almost entirely from those who are very much involved in the teaching process. The intellectual structure of every discipline is different, and the tough question of *fundamental* goals cannot be resolved in any simple, quick way. While computer scientists and educational psychologists can help develop learning material, I do not believe they can do it alone.

Myth 10: The computer used educationally uses only minor amounts of computer resources.

It is often said that student use of computers requires little core and little CPU time. While some materials exist for which this is the case, many existing examples indicate quite a contrary situation. Some of our more effective teaching programs at Irvine are very long—some are more than 200,000 words in length and so depend heavily on overlay structures. And some are extremely demanding of the computer in terms of computational and I/O facilities. In some cases these demands exceed the abilities of current timesharing, and so some programs look toward faster systems of the future. So planning for computer uses in teaching under the assumption that minimal computer resources are required is dangerous.

One undoubtedly could proceed a bit further from these myths to other commonly held misconceptions. But I have indicated some of the more important ones to take into account for the future. In spite of these myths, the future is promising for the computer as a learning device.

Reprinted with permission from the *ACM Sigcue Bulletin,* October 1973. See article on the *SIGCUE Bulletin* in this issue of EDU.

OPINION: a classroom is a classroom is a classroom - and invisible

LESLIE A. HART

For information on water, someone has suggested, one can go to better sources than a fish. Born in water, living in water, with only fleeting exposure to other environments, a fish accepts water – we must assume – as normality. Water *is.*

To teachers, the classroom is. 'School' means a group of classrooms, plus auxiliary facilities. 'Teaching' means to take charge of and work in a classroom.

One can hardly blame teachers for this viewpoint. A young teacher, 26 years of age, may have spent 20 of those years in classrooms – and possibly even one or more of the first six! Glimpses of other working environments probably have been few and superficial.

The result is evident: *the classroom becomes invisible.* I have tried many times to talk with teachers about the classroom as an organizational device, an arrangement. With rare exception, the teacher's first response is utter bafflement – what am I talking about? The classroom is not 'an' arrangement, but *the* arrangement. The Classroom *is.* The idea that the classroom represents a quite arbitrary way of handling students and putting them in relation to teachers, and that it is only one of a great many possible arrangements, can in my experience be grasped by most teachers only after they have been exposed to it again and again in a variety of ways. Even then it comes hard – clearly many who get the idea intellectually don't *really* believe that formal education can be carried on without using the familiar classroom structure!

I see this as one of the prime difficulties in effecting change from conventional practices. Until all concerned comprehend clearly that the classroom constitutes nothing fundamental or inevitable, but merely one choice of many, no valid sense of alternatives usually develops. Recently I observed a group of earnest, devoted teachers struggling to set up what they called a team teaching experiment, within a conventional classroom school. Obviously they were still thinking of large groupings as large *classes,* or combined classes, and of smaller groupings as students taken *out* of class. Team teaching as an *alternative* to classroom organization simply escaped them altogether.

Today, frustrated, angry and militant teachers are not hard to encounter; but few indeed seem to realize how much of their troubles derive from the classroom style of organization. When Horace Mann brought this structure to the United States for public school purposes, it found rapid acceptance in the more urban areas largely because it solved the teacher problem of the day. No longer was the 'schoolmaster' needed. Innocent maidens and spinsters could be hired readily at under a third of the previous cost. Further, they could be rigidly directed and closely supervised – so the cheap help could produce an educational output at least superior to the negligible effect of the type of school the Mann importation replaced.

The structure *designed* to utilize cheap help survives intact and little altered in our class-and-grade schools today. As help becomes less cheap, crises develop – witness the universal budget squeezes, and even close-downs, of school systems across the continent. But teachers so seldom *look* at the classroom system as an organizational system that they do not grasp its economic implications for them.

In other ways, too, this long outdated structure takes its toll of teachers day by day and makes their role absurd and unplayable from the outset:

- Decade by decade, the teacher's job has become more complex, until today it calls for a combination of skills, from dealing with angry parents to diagnosing learning difficulties, that no one person on earth possesses. The principle of division of labour, of concentration of skills, is routinely applied everywhere but within classroom schools.
- The teacher's job is not a job, but rather a hodgepodge of duties, from housekeeping, clerical, and custodial on up. To demand high pay and 'professional' status while performing low-level duties is an all too apparent contradiction.
- The teacher knows how widely children differ, but the classroom forces effort in the direction of fictitious alikeness. Somehow, all the children must be made to 'cover' the same material, in the same fixed length of time. Frustration becomes inevitable.
- The classroom puts the teacher in the worst possible position to cope with the disturbed or fractious child. Any student can halt proceedings at any time.
- The classroom puts the student automatically in the role of prisoner, rightless person, and inferior, while the teacher is cast as oppressor, jailer, judge and prosecutor, and informer. For the student the situation is basically aversive; and remarkable indeed is the teacher who can overcome these antagonistic relationships, built right into the 125-year-old classroom structure.
- The classroom levels out ability and competence. The newest, rawest teacher, and the least devoted or able of whatever vintage, have the same duties, title, responsibilities, and authority as the best teacher in the school. One teacher may be paid twice as much as another for precisely the same work, less well performed.
- The classroom isolates the teacher, making learning from others difficult and restricting interchange of ideas. And by limiting normal contact with other adults, it has a long-observed, deadly effect on mental health.
- The classroom, requiring many hundreds of interpersonal exchanges daily within a basically aversive, combative, and tension-loaded situation, makes teaching an exhausting job – in marked contrast to the pleasures and satisfactions of assisting learning in non-classroom situations.

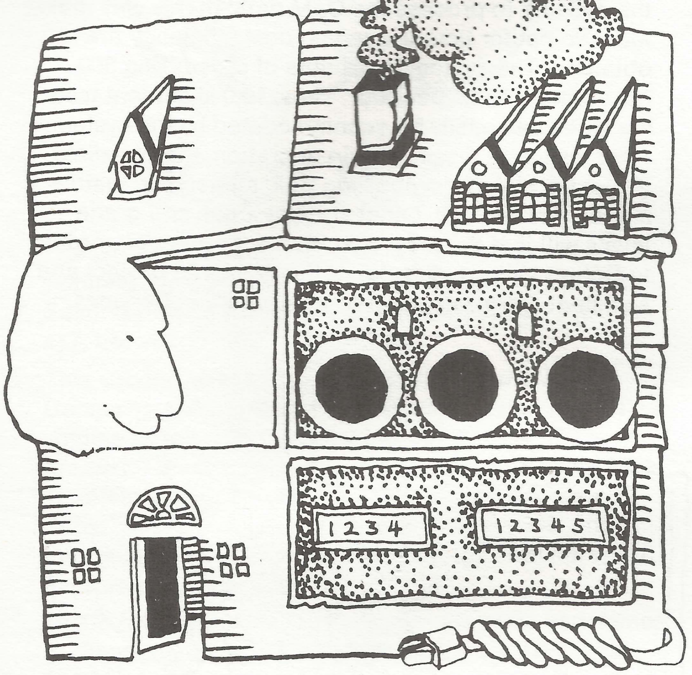
The list could be easily extended. But surely it is long enough to suggest that teachers have a great and urgent stake in learning more about alternative forms of organization – that can dump the classroom into the rubbish bin where it belongs.

Once one begins to *see* the classroom, it becomes quite plainly the prime source of most of the troubles we have in our schools today.

Reprinted with permission from the Autumn 1971 issue of the *Toronto Education Quarterly,* published by The Toronto Board of Education.

About the Author: Leslie A. Hart is a writer/consultant and author of *The Classroom Disaster,* Teacher's College Press, Columbia University, 1969. His new book on Proster Theory, a new brain-based concept of learning, is scheduled for publication shortly.

PRODUCTS AND NEWS



SUMMER SCIENCE FOR HIGH SCHOOL STUDENTS

Next summer several thousand of the Nation's top high-ability high school students will participate in intensive science and study projects supported by the National Science Foundation (NSF).

The students will be participating in the Foundation's Student Science Training Program (SSTP), which offers science opportunities beyond those presented in high school courses. The projects range from geological research that requires students to assist with experiments under rugged arctic conditions to those that enable students to study technology, visit industrial centers, and work with university scientists. Other projects offer students opportunities to serve as aides to government officials while studying political science, or to conduct anthropological research at archeological excavations. They cover a wide range of the natural, physical, and social sciences and technology.

Projects range from five to ten weeks in length. Costs of instruction are usually covered by an NSF grant, although some projects may require students who can afford to do so to pay tuition. Most participants pay their own expenses for room, board, and travel.

Also, admission to SSTP projects is determined by the sponsoring institution, not by the National Science Foundation. In general, selection is based upon scholastic ability, science motivation, and the completion of specified high school courses in science and mathematics.

A directory listing institutions offering SSTP projects will be available from NSF about mid-March, and may be obtained by a postcard request addressed to Student Science Training Program, Student-Oriented Program Group, National Science Foundation, Washington, DC 20550. ☐

MORE DIGITAL IN THE NEWS

NOVEMBER, 1973	COMPUTERS AND AUTOMATION Cover photo featuring students at the United Nations International School using their EduSystem 25.
DECEMBER, 1973	THE MATHEMATICS TEACHER "Supertoys, A New Approach to Learning Mathematics" deals with Seymour Papert's project utilizing the Turtle, other devices and a PDP-11 RSTS System to teach mathematics to elementary children at the Artificial Intelligence Lab at MIT. (See article in this issue)
DECEMBER, 1974	THE JOURNAL: TECHNOLOGICAL HORIZONS IN EDUCATION* "The MiniComputer in School—A Good Report Card" by Robert E. Bachelder. Discusses the administrative and instructional applications of Melrose Public Schools' (MA) EduSystem/EDP System. Cover features students at the United Nations International School, New York.
APRIL, 1974	INDUSTRIAL EDUCATION "Learning By Teaching - The Computer as Student" by Darrell Smith. A cover story which describes the successful application of an EduSystem 50 in the career education program at the District One Technical Institute, Eau Claire, Wisconsin.
APRIL, 1974	SCHOOL MANAGEMENT "Small Computer Brings Big Improvements" by Barney Peltier. Sierra Vista Public Schools' EduSystem/EDP brings academic and administrative improvements on a district-wide basis.

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* *THE Journal* is a new educational periodical published monthly by Information Synergy, Inc., P. O. Box 992, Acton, Mass. 01720.

A SYSTEM FOR COMPUTER-BASED INSTRUCTIONAL MANAGEMENT

The Application

Computer technology is now being used to help manage the instructional activities of students, teachers, and administrators, using a DIGITAL PDP-11 computer system. A new assessment system, called Comprehensive Achievement Monitoring (CAM), is being used in school districts throughout the country.

Some installations use abbreviated assessment systems which generate a subset of the more than 50 report formats available. The full CAM3 System on the PDP-11 preprints and preslugs information on a machine-scorable answer sheet so that a student need only mark the sheet with the date and his answers to the test questions. The computer corrects the tests, returns outputs designed for use by teacher and student, and builds a complete file of each student's performances on all tests and all items. This file provides a base for semester-end and course-end data analyses which support curriculum validation, modification and refinement.

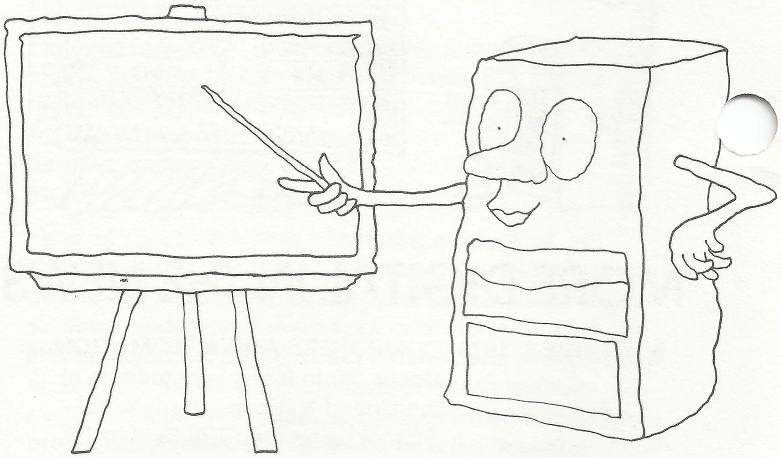
The CAM design includes the following components:

1. A curriculum defined in terms of performance objectives.
2. Test items that measure student performance on each objective.
3. Sets of comparable test forms; each form measures either a sample or all of the objectives in the curriculum.
4. Testing throughout the course at specified intervals: before, immediately following, and periodically after instruction.
5. Computerized analysis and reporting of results within 24 hours after the administration of each test.
6. Interpretation of results by students, teachers, administrators, and parents, leading to decisions concerning study priorities, instructional activities, and curriculum content.
7. Modification of the curriculum, instructional activities, and evaluation design based on the CAM results.

Each of the components is an integral part of the evaluation cycle. Evaluation becomes an on-going process that provides students, teachers, administrators, and parents with continuous feedback for immediate and long-term decision-making.

Students can determine their strengths and weaknesses and see in what areas they need to study. Teachers can use the information to improve the instructional process and refine the curriculum. Administrators can monitor the attainment of district-wide goals. Parents can understand the goals and objectives of instruction and monitor their children's growth on these objectives over time.

The complete software system is presently operational on a DIGITAL PDP-11/45 in the Westfield (Mass.) Public School District. The system supports time-shared BASIC terminals during the day and is converted to a disk operating system mode (DOS-11) in the evening to process the CAM data. In this way maximum computer time usage and cost efficiency are obtained. The system is capable of processing 500-700 students tests per hour. Thus, 10,000 student tests per week can easily be accommodated by the system. After less than a semester in operation, the Westfield Project is already supporting 2300 students in mathematics (grades 5-8). Other subject areas and grade levels will join the project in the near future, according to Robert Gilbert, director of the Westfield project and Assistant Superintendent for Instructional Services.



A typical CAM year-long course covers approximately 100-125 instructional objectives. Tests are administered approximately every two weeks throughout the year. The testing of objectives not yet taught *(pre-instruction testing)* allows the instructor to plan the next two weeks' instructional activities. The testing of objectives recently taught *(post-instruction testing)* allows for the review of objectives not learned. The testing of objectives taught several weeks previously *(retention testing)* allows for the review of objectives learned but forgotten.

During the summer, teachers and curriculum coordinators use special reports generated from the data base created during the school year to revise the curriculum. This revision includes rewriting test items and objectives, deleting and adding objectives, and resequencing the order of presentation of the objectives.

An actual example of the use of CAM at the district level is the Westfield mathematics basic skills program. Once a month students are administered tests. Five random parallel test forms are administered per grade level with each student taking a different form at each administration. The data are reported for each school and grade level.

The results are used to diagnose individual student deficiencies and place those students in the appropriate instructional program. The teachers use the results to plan instructional programs for the coming year. The results are valuable to the feeder schools, who can modify their instructional activities to compensate for the particular deficiencies of their student population.

Computer Hardware and Software

The CAM system is being employed throughout the country on various computer hardware configurations. Mini-computers like the PDP-11 are especially well suited for processing of student assessment data because of their low cost and space requirements.

The computer software that is used to process the CAM data has been developed over the last six years under the aegis of National Evaluation Systems. The programs are written in American Standard FORTRAN and have been thoroughly debugged in schools throughout the country. There are over 50 report formats available for students, teachers, administrators, and parents so that reports may be selected that meet the needs of a variety of educational environments.

Additional Services

In addition to the CAM system, questionnaire analysis and standardized test analysis systems are available. Instead of having to contract externally for assessment of prescribed tests, a school system may evaluate its own instructional modes, curriculum, and test structures. The long-term savings and increased effectiveness of school programs result in a comprehensive instructional management package.

National Evaluation Systems, Inc. offers several products and services to support a Comprehensive Achievement Monitoring system. These products and services include:

1. Teacher, administrator, student and parent training.
2. Performance objectives and test items
3. Project planning
4. Computer software
5. Data processing training

For additional information and a copy of the CAM3 brochure, contact the National Evaluation Systems, Inc., office nearest you:

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ISL-MINIPOINT

Meet ISL-MiniPoint—an economics major for solving differential equations in engineering simulation, curve fitting and process control applications. Problems may be entered, edited and executed in one interactive operation; the unlimited numerical range, coupled with error checking and diagnostics, makes ISL easy to use. The first system became operational last July. Since then, five universities and five industrial installations have been made.

Dr. Ludwig Braun (State University of New York) had this to say about ISL:

"The ISL system has one important advantage over better-known languages like MIDAS and CSMP: it permits hands-on interactive operation. The user can sit at the computer, monitor the course of the computation and change parameter values during execution."

Mr. Dwain Worster of Douglas United Nuclear Corporation has found the speed of ISL to be impressive. "Our mini-computer will execute several times faster with ISL than languages like CSMP or MIDAS on large computers."

ISL-MiniPoint will operate in 4K of core memory with a teletype. Supported CPU's include PDP-8, PDP-12 and the PDP7/9/15. Development for the PDP-10 and PDP-11 processors is under consideration. The system can be expanded easily to handle most peripheral devices and up to 32K of core (12K for the PDP-8/12).

For more information about ISL-MiniPoint, contact Interactive Mini Systems, Inc., 5312 West Tucannon, Kennewick, Washington 99336. Mention EDU.

INVESTIGATING COMPUTER SYSTEMS

Investigating Computer Systems is a fifteen-lesson course in basic computer technology, which provides extremely flexible and effective material for coursework in computer familiarity and basic data processing. The course is a multi-media package which includes 35mm color filmstrip lessons, student programmed instruction sessions, quizzes and teacher's guides. The lessons cover topics in computers and business, computer codes, communicating with computers and elementary programming. The material is particularly suitable for the junior/community college curriculum.

For more information about *Investigating Computer Systems* ($500) write to: Mealey Productions International, Inc., Suite 102, Executive Building, 22 West Road, Towson, Maryland 21204. Mention EDU!

GEORGIA TECH DEVELOPS "DECSYSTEM-8"

"DECSYSTEM-8" is the newest and most comprehensive enhancement to the PDP-8's operating system since the introduction of OS/8 itself. It doubles the number of commands available to the user and provides him with the capability to define additional commands easily. Unlike past major developments on the PDP-8 operating system, "DECSYSTEM-8" was developed by users.

John Covert and Doug Wrege from the Georgia Institute of Technology have patterned "DECSYSTEM-8's" thirteen additional commands and the extended library of systems programs after the large DECSYSTEM-10 operating system. Among the most useful features are the capability to "batch" process in 8K of core memory and to keep machine usage records. The accompanying chart summarizes "DECSYSTEM-8's" enhanced features.

"DECSYSTEM-8" was designed for compatibility. With a few exceptions all present PS/8 and OS/8 systems programs run under it. The command syntax of DECSYSTEM-10 and "DECSYSTEM-8" are also compatible, allowing users to easily converse with both the PDP-8 and PDP-10.

"DECSYSTEM-8" COMMAND SET

Existing PS/8-OS/8 commands

.R
.RUN
.SAVE
.START
.GET
.ODT

Modified Commands

.DATE	— extended to print the day of the week whenever the date is changed and to allow checking of the date without changing it.
.ASSIGN	— with no arguments, now reads in labels recorded on DECtape or LINCtape and makes automatic device assignments.
.DEASSIGN	— with no argument, removes the user device name from that one device only.

New Commands

.LOGON	— keeps records of system usage, and provides control over system device file storage.
.KJOB or OFF	— keep records of system usage, and provide control over system device file storage.
.CREATE or .EDIT	— call the editor for creation and editing of files.
.TECO	— call the TECO editor for creation and editing of files.
.COMPILE	— provides the facility for directly calling the system compilers and assemblers.
.DELETE	— allows deletion of several files on many devices in one command.
.RENAME	— allows the user to change the names of files.
.DIRECT	— produces a listing of the directory.
.FILE	— allows several files to be transferred to or from the system device in one command.
.SUBMIT	— calls the program HASP to run the file specified as a batch job.
.FOCAL	— gets the previously stored FOCAL program and executes it.

"DECSYSTEM-8" COMPONENTS

"DECSYSTEM-8"	— Monitor (created from PS/8)
"DECSYSTEM-8"	— Command Decoder
COMPILE	— Code to process extended commands
DIRECT	— Directory listing program
DATE	— Handles printing of date and optional "message-of-day"
LOG	— Handles dialogue at sign-on and sign-off
UMOUNT	— Handles file R and file commands
HASP	— Provides batch operation
AUTOASSIGN	— Routines for tape labeling

"DECSYSTEM-8" is available on DECtape and LINCtape from DECUS. Users should specify DECUS Number 8-646 when ordering. For technical details on the system, contact:

John R. Covert
School of Information and Computer Science
or
Douglas E. Wrege
School of Nuclear Engineering and
Nuclear and Biological Sciences Division, E.E.S.
Georgia Institute of Technology
Atlanta, Georgia 30332

POTPOURRI (Articles, Reports and Activities)

CALL FOR PAPERS AND ARTICLES

Are you using a computer in your course? Or for research? Or for school administration? If so, have we got a deal for you!

Perhaps you've thought that your application wasn't on the forefront of technology, and no one would want to hear about it. Or maybe you just could never find the time to write about it. Or perhaps you don't fancy yourself as much of a writer? Well, this offer is still for you!

EDU is willing to pay $20 (Yes, TWENTY DOLLARS!) for any article used in EDU (or any other Digital publication) about the use of computers in schools. Elementary schools. Research projects. Middle schools. University computer centers. Anyplace in education.

AND an additional $5 (FIVE DOLLARS!) will be paid if usable photos are enclosed (black & white glossy, 5 x 7 or larger). Articles and papers should be between 500 and 2000 words. Don't worry about your writing—we'll edit and revise if necessary. Of course, don't submit papers or articles that have been submitted to another national journal.

So they don't get mixed in with the rest of our mail please send your material directly to EDU, Contributions Editor, Education Products Group, 5-5, DIGITAL.

Looking forward to hearing from YOU!

MEETINGS OF INTEREST

REGIONAL:

Feb.	21-23	NCTM, National Council of Teachers of Mathematics, Portland Meeting, Portland, Oregon
Mar.	7-9	NCTM, National Council of Teachers of Mathematics, New Orleans Meeting, New Orleans, Louisiana
Mar.	28-30	NCTM, National Council of Teachers of Mathematics, Des Moines Meeting, Des Moines, Iowa

NATIONAL:

Feb.	22-26	AASA, American Association of School Administrators, National Meeting, Atlantic City, N.J.
Feb.	25-27	AACJC, American Association of Community and Junior Colleges, Annual Exposition, Washington, D.C.
Mar.	1-6	NASSP, National Association of Secondary School Principals, Annual Meeting, Atlantic City, N.J.
Mar.	12-15	Western Annual National Educational Technology Conference, San Francisco, California
Mar.	15-19	NSTA, National Science Teachers Association, Annual Convention, Chicago, Illinois
Mar.	24-27	Eastern Annual National Educational Technology Conference, Miami Beach, Florida
Mar.	27-29	ATEA, American Technical Education Association, National Clinic, Columbia, S.C.
Apr.	15-19	AERA, American Educational Research Association, Annual Meeting, Chicago, Illinois
Apr.	17-20	NCTM, National Council of Teachers of Mathematics, Annual Conference, Atlantic City, N.J.
May	7-10	AEDS, Association of Educational Data Systems, Annual Conference, New York City
June	24-26	CCUC/5, The Fifth Annual Conference on Computers in the Undergraduate Curriculum, Washington State U., Pullman, Washington

THE ADVANTAGES OF SIMULATION FOR INSTRUCTION

This article is an except of an invited paper by Judith B. Edwards, University of Iowa, entitled "Simulation For Instruction: Some Considerations for Users and Designers." The paper appeared in the *ACM Sigcue Bulletin,* April 1973. (See article on the *Sigcue Bulletin* in this issue of EDU.)

Various theories about how people learn appear to be served by simulation. Bruner (1) reports a conference consensus that the fundamental structure of a discipline—as opposed to factual detail—is the proper stuff of education. A well-designed simulation forces attention to the inherent structure and fundamental themes at hand.

Related to Bruner's theory is the notion of "discovery" —the idea that mastery of the fundamental structure of a field involves development of an attitude toward learning and inquiry, guessing and hypothesizing, discovering relationships and generalizations for one's self. In the responsive environment provided by a simulation, the student has the opportunity to discover or uncover a series of fundamental relationships. He is encouraged to explore the system with freedom, to ask "what if?" and to actively experiment with the system. Independent variables can be freely manipulated to test guesses and hypotheses.

Another notion inherent in Bruner's theory is that the best stimulus for learning comes from the subject matter itself, from an intrinsic student interest in the material. Simulations appear to be intrinsically interesting, if one can judge subjectively. The superior motivation of students in educational simulation is widely recognized. In fact, the motivating effect is probably the only indisputable claim for the value of using simulations.One research study (2) showed little gain in learning or retention in the experimental (simulation) group, but a significant gain in motivation.

Research has presented evidence that it is important in both behavior and learning for a student to believe he has control over his own environment. Such a belief is a good predictor of school achievement. Simulation can provide opportunity for the student to experience situations where the outcomes are clearly contingent upon his own behavior, and which are similar enough to real life situations to allow generalization.

The "identical elements" theory of transfer in learning holds that maximum transfer takes place when the learning is as nearly like the real world as possible. There is difficulty in bringing "real world" problems into the classroom. The result is that students see little relevance in school activities for their real lives.

Simulations bridge the relevance gap by bringing a representation of the real world into the classroom. Students may practice interacting with this model, making decisions and exploring hypotheses, without suffering the real life consequences of their actions. The student is protected from the dangers of reality as he develops and tests strategies for coping with reality. As well as being safer, the simulated system is probably cheaper, simpler, less time-consuming and more readily reproducible than comparable experience in real life.

Opportunities for individualization of instruction are provided by simulation. Even relatively simple simulations can be sufficiently rich in content to provide several levels of learning for students of varying abilities. Slower learners can focus on the concrete, static elements while faster learners can attempt to apply concepts of cause and effect.

It is possible in designing a simulation to provide for variations in content, length of segment, style, and mode of presentation, as well as the sequence and difficulty of the problems presented.

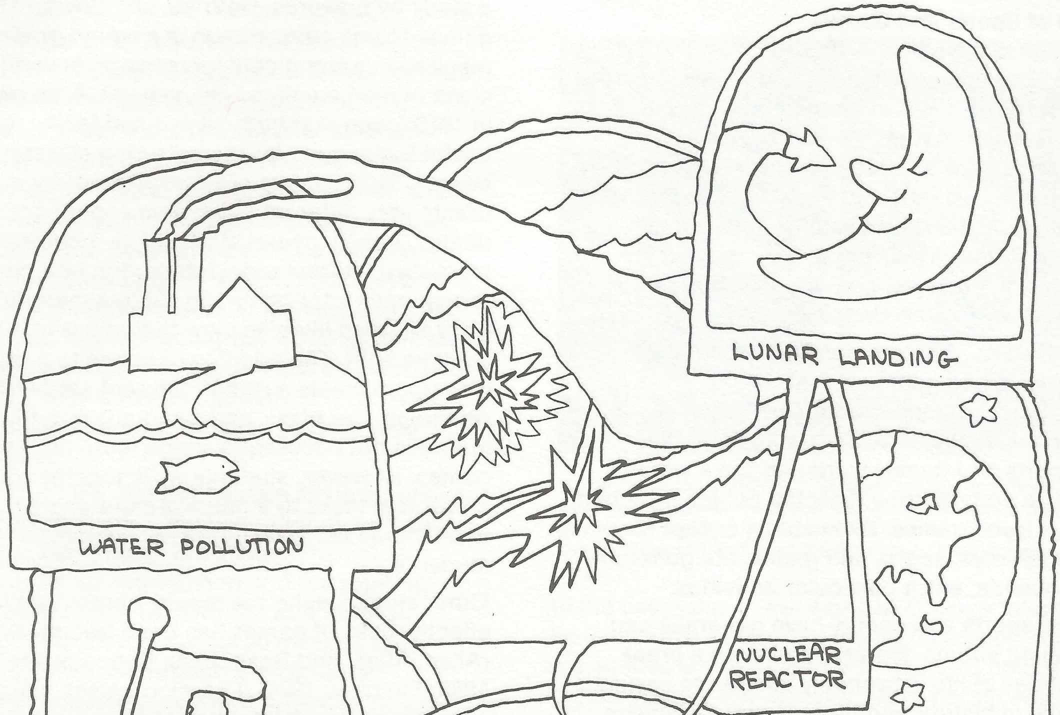
Finally, the self-pacing nature of a simulation contributes to individualization. A simulation is able to focus the attention of the student in much the same way as programmed instruction does, by requiring active participation. Participation in a simulation as decision-makers gives students insights into decision-making processes. They also gain empathy and a greater understanding of the world as seen and experienced by real decision-makers.

The responsive environment of a simulation provides feedback on the consequences of actions. Thus the learner can play out a strategy over a period of time and determine from the feedback how effective the strategy was. The feedback gained is not only more lucid and faster than that provided in other settings, but it is perceived as less arbitrary.

Many ideas we may wish to present to students are either too abstract, too difficult, too remote from students' experiences, or too complex for them to understand. In real life, a system (a social system, for example) may be so confused and chaotic that it is hard to segregate the important variables and see the relationships between them. In a simulation, the phenomenon under study may be highlighted by abstracting simple elements from the confusion of reality. The effects of interactions are intensified. A simulation can be complex compared to verbal models, but simple compared to the real world. This is a rewarding compromise: the simulation has enough complexity to account for the significant sources of variance in the real world, but is simple enough to be understood.

It has been claimed that instructional simulation helps to "build intuition" or "encourage intuitive problem solving" (3). Perhaps this is so. Certainly a student is encouraged to test hunches and is rewarded for the superior problem-solving speed of effective intuition.

A SIMULATION IS:



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(2) Boocock, S. S. & Schild, E. O. (Eds.) *Simulation Games in Learning.* Beverly Hills, CA: Sage, 1968.

(3) Abt, Clark. *Serious Games.* Cambridge, Mass.: Abt Associates, 1964.

TEACHING WITH COMPUTER GAMES

by David H. Ahl

Brief History of Sports and Games

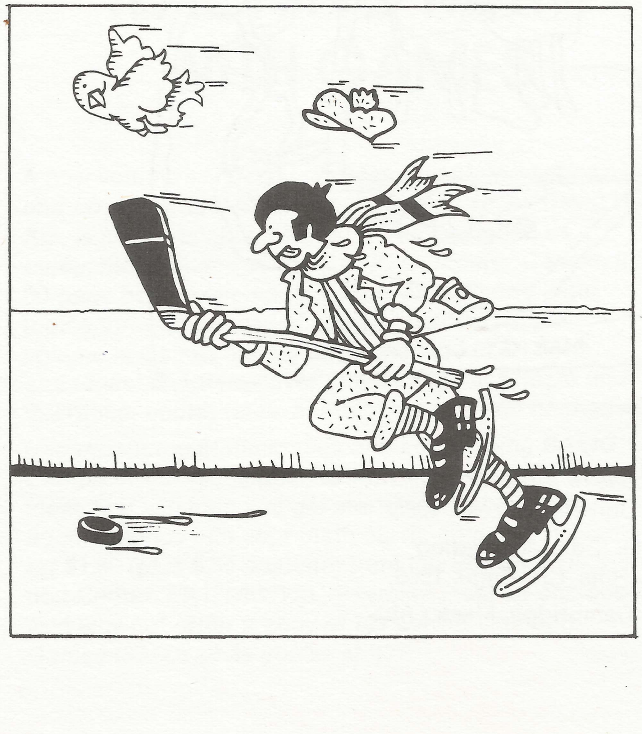
Sports and games have been with us almost since the dawn of man. The ancient Chinese and Egyptians devised an astonishing array of mathematical and logical games (Nim, Towers of Hanoi, Awari or Kalah, etc.). The Greeks originated a great many physical games in their Olympic competitions. Medieval Europe was responsible for many games played for recreation in nobles' courts (Chess, Hi-Q, etc.). Team games are a phenomenon of the last few centuries, with many originating in England and the United States.

Throughout history, the common thread running through all sports and games is that their intended function has been purely recreational. Games were viewed as a diversion from the realities of life. Secondly, sports and games were and are a leisure-time activity. In early Europe, only the nobles, who had leisure time, played games. Even today, except for professional athletes, sports and games are generally considered outside, extra-curricular activities.

Nevertheless, sports and games have generally had some redeeming virtues. Merely serving as a break from the realities of life is probably enough to assure games a place in history. But there is more. Chinese philosophers spoke of games as sharpening one's wit. Sports build the body just as card, board and mathematical games build the mind. Team games heighten the spirit of trust and cooperation.

Games as an Educational Tool

Not until the last 10 or 15 years of educational innovation, however, have games ever been used primarily as an educational tool where learning is the primary purpose of playing. Today, there is a growing body of evidence which indicates that a combination of learning games and student teams may well be one of the most effective approaches to learning ever devised. In a study by Edwards, DeVries, and Snyder (1972), the games-teams combination in seventh grade classes resulted in a significant increase on several dimensions of mathematics achievement. A follow-up study in 1973 found that both games and teams represent useful techniques for restructuring classroom processes. Their effects are complementary in that they create very different classroom experiences for students. Games cause students to translate their increased interpersonal interaction into increased informal peer-tutoring on the subject material at hand. They are also likely to view their class in a much more positive light. The addition of teams to a traditional classroom meets a rather different set of objectives. Attending the class and encountering the subject matter is not necessarily made more fun as it is with games. However, students work together on traditional classroom tasks to a much greater degree, resulting in an increased level of mutual concern among the students.



Other studies echo the results above. The learning effectiveness of games has been frequently cited (Allen, Allen, and Ross, 1970; Boocock and Schild, 1968; Fletcher, 1971). Learning games generally create an intense and often enjoyable interpersonal experience. This is due in part to the interdependent task structure which requires interaction among the players (Inbar, 1968).

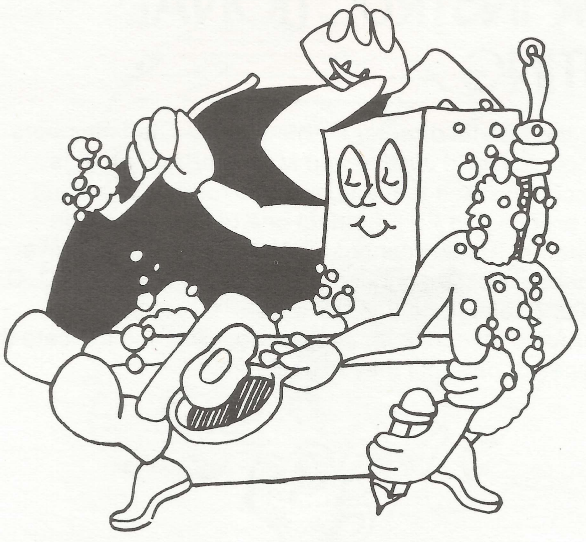
Teams have been in use longer as an educational technique. Generally it has been found that students in a team outperform students working as individuals. A key reason for the effect of teams has been the high rate of peer tutoring (Wodarski, Hamblin, Buckholdt, and Ferritor, 1971).

As mentioned earlier, because games and teams positively affect different classroom processes, combining the two techniques creates an even more powerful effect on the learning environment. This in turn is translated into greater academic growth as well as increased trust and cooperation.

Computer Games and Simulations

People have written games for the computer almost since its birth. Many tended to be copies of real life sports and games (football, poker, tic-tac-toe, etc.). Other games were written as simulations of other real processes with a recreational quality (lunar landing, parachute jump, artillery weapon firing, etc.). Still other computer games were devised mainly for their recreational and mind-challenging value (game of life, bulls and cows, bagels, mugwump, etc.).

The educational value of both playing and writing computer games is substantial. They make ideal supplemental learning experiences when teaching about probability, statistics, logic, problem solving, decision making, and value clarification.



Getting Started

To make it easy to start using computer games in the classrom, DIGITAL has published two new books:

1. *101 BASIC Computer Games*	$5.00
2. *Understanding Mathematics and Logic Using BASIC Computer Games*	$1.50

Both books may be ordered for the prices indicated (plus 50 cents postage and handling) from the Software Distribution Center, 1-2, DIGITAL.

Payment must be enclosed with order.

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BEHIND THE SIMULATION SCENE

It is well known that the Huntington Project staff has produced a wealth of valuable simulation materials for secondary school applications. And in other projects, schools and colleges around the world, students and faculty are designing and using simulation materials in other disciplines. But did you ever wonder about the steps that are required to produce educationally sound classroom computer simulation materials? Here is a summary of efforts from behind the simulation scene—as we, at EDU, see it!

STEP 1: Choose a Topic

A topic is suitable for computer simulation if it is otherwise too dangerous, expensive, requires an unreasonable time frame, or is impossible to experience under other circumstances.

The simulation designer must have substantial knowledge of the topic, and must be able to assign quantitative values to variables, as well as understand the relationship between the variables under different circumstances.

Unless both of the above are true, a topic is not suitable for simulation.

STEP 2: Identify the Audience and the Objectives

Although audience overlap is quite common, it is essential that the simulation be based on specific prerequisite knowledge and be aimed toward a standard ability level. Instructional objectives should be stated for the program.

STEP 3: Design the Model

Parameters for the model are chosen and variables must be analyzed, quantified and chosen or rejected, based on their importance and their relation to the objectives. Redundant or distracting variables should be discarded.

STEP 4: Write The Program

The model is translated into a suitable computer language; program testing and debugging follows.

STEP 5: Document the Simulation

Program documentation should include background information, objectives, student prerequisites, description of the model, operation instructions, sample output, activities, and resource information. Ideally, the appropriate documentation is contained in teacher and student guides.

STEP 6: Classroom Testing

Both the program and the attendent curriculum materials must be classroom tested to evaluate the validity of the model and the instructional materials. Revision, rewrite and further testing will likely be required before the simulation can be considered a finished product.

Now—why not try your hand at simulation designing? (See the article in this issue entitled "Call For Simulation Programs"!)

FUNDING SOURCES FOR INSTRUCTIONAL COMPUTING

From time to time, requests for information regarding funding sources for instructional computing programs are received by the Education Products Group. An article of the same name by Richard B. Heydinger appeared in the May 1973 issue of the ON-LINE newsletter.

Mr. Heydinger is associated with the Center for the Study of Higher Education, University of Michigan. Excerpts of his work are presented here.

Federal Programs

When discussing the federal funding sources, one caveat is important. The milieu in Washington is presently in such a state of flux that any description of the funding programs for education can be out-of-date within a few weeks. Hence proposal writers must keep abreast of the day-to-day developments to insure that their information is accurate and their proposals are well received.

Presently there are three federal programs which are viable possibilities for the support of instructional computing. The first, which represents the largest source of federal funds, is the newly created National Institute of Education (NIE). This institute was established as an autonomous agency within HEW, and all funded research programs formerly supported by the Office of Education are now centralized in a single NIE program directed by Thomas Clemens. This "Grants for Research in Education" program relies on field-initiated proposals. It has budgeted $10 million for FY 1973 awards and has requested $20 million for FY 1974. Proposals must be directed at one of three broad areas according to size and type of grant activity: (1) large grant activity; (2) small grant activity—under $10,000; and (3) selected disciplines.

Prospective proposal writers should carefully examine the NIE guidelines to determine the area for which their project is best suited. Guidelines may be obtained by writing the National Institute of Education, Department of Health, Education and Welfare, Washington, D. C. 20202.

A second source of federal funds is the Fund for the Improvement of Postsecondary Education (FIPE). Similar to NIE, the Fund is a newly created and autonomous unit within HEW. Hence it too lacks historical data, which is further complicated by the fact that its funding level for FY 1974 is very much in doubt. Current FIPE guidelines emphasize projects which examine cost-effectiveness, diversity, and/or structured change in the curriculum. Instructional computing proposals submitted to FIPE must demonstrate wide impact and *focus on the learner and structured (curricular) change* rather than equipment purchases. Presently Mr. Russell Edgerton is the interim director of this agency. Staff members include David Justice and Michael Brannon. It is recommended that any one who intends to submit a proposal to FIPE contact one of these persons directly (Department of HEW, Fund for the Improvement of Postsecondary Education, Washington, D. C. 20202, telephone 212/962-3811). This contact will provide guidance for proposal writing and indicate the types of projects they expect to fund.

A third source of federal funds is the recently reorganized National Science Foundation. In the past NSF has made awards to instructional computing projects through the Office of Computing Activities, particularly the Computer Innovation in Education Section headed by Arthur S. Melmed. Recently, however, this section was transferred intact to the Education Directorate of NSF and renamed "Technological Innovation in Education." (The Office of Computing Activities continues to function, but only supports computer science projects and computer applications in research.) Working with Dr. Melmed in the Directorate are Erik McWilliams (directing the Technology and Systems Project), Andrew Molnar (directing the Computer-Oriented Curriculum Activities), and Lawrence Oliver (directing the Special Programs Computer Activities). Inquiries and preliminary proposals (in 3 copies) should be addressed to one of these gentlemen at: The Education Directorate, National Science Foundation, 1800 G Street N.W., Washington, D. C. 20550, telephone 202/282-7944. Recently this NSF group has been most active in their support of two large-scale CAI demonstration projects at the University of Illinois (PLATO) and at Mitre Corporation (TICCIT) and regional computing activities. *(NSF has also supported projects at the University of Pittsburgh (Project Solo), and State University of New York at Stonybrook (Huntington).—Ed.)*

→

COMPUTER PROGRAMMING AND MURPHY'S LAWS

These laws were written and submitted by Donald Sannella, student at Lexington (MA) High School.

Law 1: The length of a crash is inversely proportional to the amount of time left until the next class begins.

Law 2: The probability of a crash is directly proportional to the importance of the program being worked on, which is multiplied by 10^4 if the program has not yet been saved, and again multiplied by ten times the square root of the number of lines in the program.

Law 3: The frequency of crashes is inversely proportional to the number of days left to complete an assignment.

Law 4: The number of disk segments remaining will always be at least 5 fewer than the number required to store a program.

Law 5: The student DECtape must always either be full or malfunction.

Law 6: The number of errors appearing in a program at the last minute is directly proportional to the amount of time spent in debugging.

Law 7: The probability of there being a free teletype is always negligible, regardless of the importance of the assignment.

Law 8: The number of mistakes in any program at any time is equal to the number of times per second bit 4 in the AC blinks, multiplied by 43.6.

Law 9: Perfect programs aren't and functioning subroutines don't.

Law 10: A breakthrough always occurs between 3:26 PM and 3:29 PM. It will always be forgotten by the next day.

The Universal Axiom: The line printer is always in use.

Definition—If an eletronic device is large, expensive, has several teletypes and other peripherals connected to it, and never performs an addition properly, we call the electronic device a COMPUTER.

> The new education must teach the individual how to classify and reclassify information, how to evaluate its veracity, how to change categories when necessary, how to move from the concrete to the abstract and back, how to look at problems from a new direction—how to teach himself. Tomorrow's illiterate will not be the man who can't read; he will be the man who has not learned how to learn.
>
> —Herbert Gerjuoy

Private Foundations

In generating a proposal for a private foundation there are many possible approaches and certainly no single method is best. Some general guidelines however are applicable to most situations. Once a project has been thought out, a list of possible funding sources must be drawn up. To assist in this, foundation reference guides are available which present pertinent information including persons to contact, programs recently funded, and a list of board members for each private fund.

The Tafts Information System Foundation Reporter (Taft Products, Inc., 1000 Vermont Avenue N.W., Washington, D. C. 20005, telephone 202/347-0788) contains a nationwide alphabetized listing of the foundations complete with background information on each director.

The Foundation Directory (Columbia University Press) contains a state-by-state listing of foundations and is a handy reference for learning more about private funds which are in your region. Each of these guides provides brief information on the procedures to follow, and certainly a quick perusal of these pages is recommended for quick overview.

If more detailed information on a foundation is required, this can be requested from the fund itself. A recently enacted law requires all foundations to send their annual corporate statement to anyone requesting it. Through this channel those seeking funds can learn more about the interests of a particular foundation.

Some Suggestions

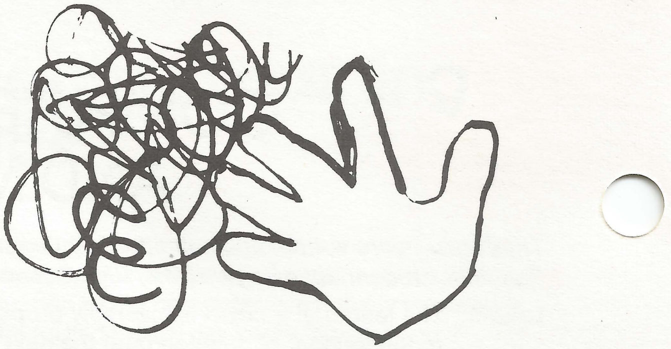
The mere thought of publicly suggesting foundations which *may be* receptive to instructional computing proposals seems at best foolhardy. On the other hand, the foundations mentioned below are those which were repeatedly suggested by people interviewed for this article.

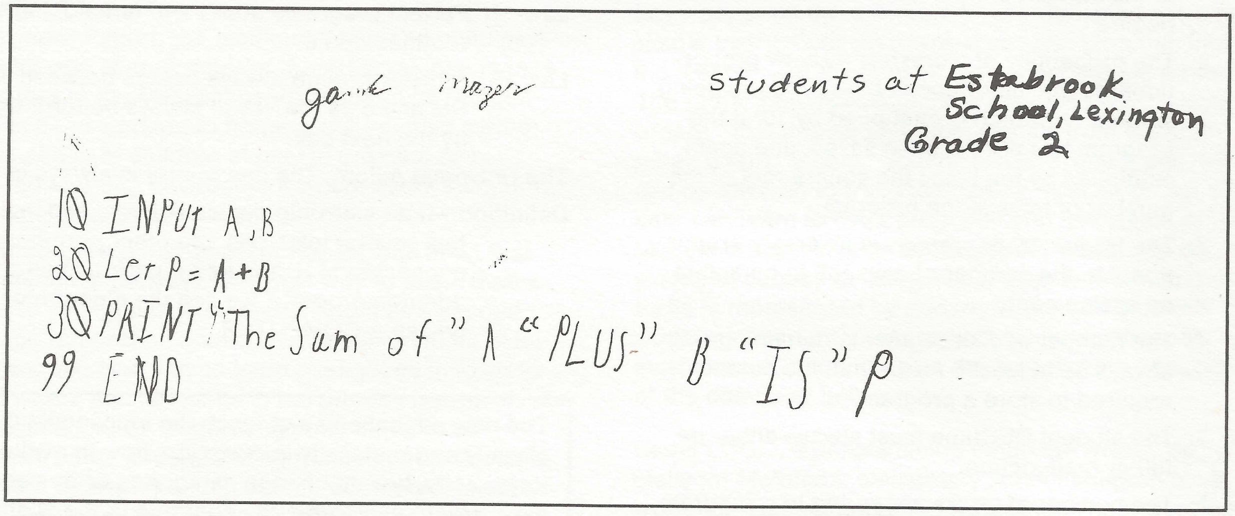
The Exxon Education Foundation (formerly Esso, 111 West 49th Street, New York, New York 10020, telephone 212/974-2273) has a history of funding instructional computing projects and is in fact the grantor for Project *EXTEND* and the publishing of *ON-LINE.*

The Alfred P. Sloan Foundation (630 Fifth Avenue, New York, New York 10020, telephone 212/582-0450), long a funding source for private college science programs, has initiated a "particular program" in the "Use of Educational Technology." Certainly this program is well suited to innovative proposals in instructional computing. *(Sloan Foundation support has been given to the LEARN project at Beloit College. See article in EDU #9, p. 11.—Ed.)*

TOO YOUNG FOR BASIC?

So you think that elementary school children could *probably* learn to write computer programs, but BASIC is *obviously* too difficult for 7 year olds? Well, here's a program that offers some proof for the theory that you're *never* too young for BASIC! It was written by a second-grade student from Lexington (MA) Public Schools. How about that!





game mazes

students at Estabrook
School, Lexington
Grade 2

```
10 INPUT A,B
20 LeT P=A+B
30 PRINT "The Sum of" A "PLUS" B "IS" P
99 END
```

THE EFFECTS OF PROGRAMMING ON MATHEMATICS LEARNING

This article is an excerpt from a paper entitled, "The Effects of Computer Programming on Performance in Mathematics," by Stuart Milner, University of Pittsburgh. The paper was presented at the AERA Annual Meeting in New Orleans, February, 1973. The research was supported by the National Science Foundation and the Learning Research and Development Center.

Eighteen fifth grade students were taught the LOGO programming language using the DECsystem-10 at the University of Pittsburgh. This summary only touches the surface of the project; it is recommended that educators interested in more details obtain a copy of the full report.

This study was designed to investigate the effects of computer programming on performance in mathematics. Toward this end, the LOGO programming language was taught to fifth grade students at the Oakleaf School, a suburban elementary school near Pittsburgh. In order to determine whether or not a conceptual aspect of mathematics could be learned through computer programming, a pretest-posttest design was employed. Results indicated that, in fact, a mathematical concept—the notion of variable in this case—could be learned through computer programming.

In addition, a study of three methods of instruction for teaching programming was made. The instructional methods—algorithm-given, incomplete-computer-program, no-information given—were considered in terms of performance in writing programs. It was found that although instructional method may facilitate the learning of programming, there were no significant differences in the criterion situation. Results also indicated that there was no effect due to ability—Stanford Achievement Test scores—in the criterion situation.

An important finding was that elementary school students could write computer programs to generate arithmetic and geometric sequences and involving variables. Some of the programs were complex and included the use of logic, recursion, and variables.

Observational results indicated that the students developed certain problem-solving behaviors. These included the planning and debugging of programs, willingness to experiment, and testing of hypotheses.

On the basis of observation, it was also found that programming is an effective learning resource in terms of affective considerations. In writing programs, the students were highly motivated, perseverant, and enthusiastic. Statements by the staff at Oakleaf were highly favorable and supportive of computer programming. The staff as well as outside observers and this investigator were impressed with the intensity and high degree of involvement exhibited by the students. Some of the students whose motivation was questionable in the traditional classroom, as indicated by their teachers, were "turned on" by computer programming.

Computer programming proved to be an exciting way of learning mathematics for the students in this study. That they did learn about mathematics was evident. That programming can be a valuable tool in mathematics instruction is also evident.

EDUCATOR SPEAK

by David H. Ahl

I'm sure everyone has seen a buzzword generator before. They were common some years ago in defense, aerospace, and other industries that tended to generate a jargon of their own. However, we educators were above all that. We used the "King's English" and could laugh at those professions that needed their own language to express the simplest thoughts.

But then last week I got a report back from a certain Federal agency with the notation that it would be more acceptable if I used the "current language of educators."

Being a rational person, I decided there was no need to rewrite the report but to simply sprinkle some highly acceptable current phrases throughout the text. Hence, I devised the table below to generate such phrases. Simply take any random word from Column A, one from Column B and one from Column C, and you instantly have a highly acceptable phrase in "Educator Speak."

A	B	C
ability	learning	grouping
basal	evaluative	modification
behavioral	objective	accountability
child-centered	cognitive	process
differentiated	enrichment	core curriculum
flexible	scheduling	algorithm
discovery	humanistic	performance
heterogeneous	integrated	reinforcement
homogeneous	non-graded	open classroom
manipulative	training	resource
modular	vertical age	structure
Tavistock	motivational	facility
individualized	creative	environment

It's easy to have your computer generate these phrases. Here is one possible version, written in BASIC-PLUS for RSTS-11:

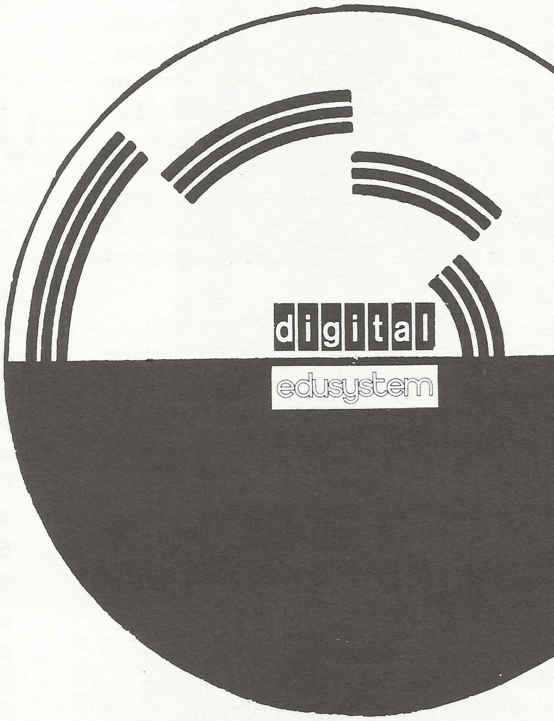
```
LIST
SPEECH  01:34 PM        13-NOV-73
10 REMARKABLE 'EDUCATOR-SPEAK' PROGRAM 'SPEECH' BY DAVE AHL

20 PRINT "THIS PROGRAM PRINTS HIGHLY ACCEPTABLE PHRASES IN 'EDUCATOR SPEAK'
30 PRINT "THAT YOU CAN WORK INTO REPORTS AND SPEECHES.  WHENEVER A QUESTION
40 PRINT "MARK IS PRINTED (?), TYPE A 'Y' FOR ANOTHER PHRASE OR 'N' TO QUIT
50 RANDOMIZE \ PRINT \ PRINT "HERE'S THE FIRST PHRASE:"
60 DIM A$(39) \ READ A$(I) FOR I=1 TO 39
70 PRINT A$(INT(13*RND+1))" "A$(INT(13*RND+14))" "A$(INT(13*RND+27))
80 INPUT Y$ \ IF Y$="Y" THEN 70 ELSE GOTO 999
100 DATA "ABILITY","BASAL","BEHAVIORAL","CHILD-CENTERED","DIFFERENTIATED"
110 DATA "DISCOVERY","FLEXIBLE","HETEROGENEOUS","HOMOGENEOUS","MANIPULATIVE"
120 DATA "MODULAR","TAVISTOCK","INDIVIDUALIZED","LEARNING","EVALUATIVE"
130 DATA "OBJECTIVE","COGNITIVE","ENRICHMENT","SCHEDULING","HUMANISTIC"
140 DATA "INTEGRATED","NON-GRADED","TRAINING","VERTICAL AGE","MOTIVATIONAL"
150 DATA "CREATIVE","GROUPING","MODIFICATION","ACCOUNTABILITY","PROCESS"
160 DATA "CORE CURRICULUM","ALGORITHM","PERFORMANCE","REINFORCEMENT"
170 DATA "OPEN CLASSROOM","RESOURCE","STRUCTURE","FACILITY","ENVIRONMENT"
999 PRINT "COME BACK WHEN YOU NEED HELP WITH ANOTHER REPORT!" \ END

READY

RUNNH
THIS PROGRAM PRINTS HIGHLY ACCEPTABLE PHRASES IN 'EDUCATOR SPEAK'
THAT YOU CAN WORK INTO REPORTS AND SPEECHES.  WHENEVER A QUESTION
MARK IS PRINTED (?), TYPE A 'Y' FOR ANOTHER PHRASE OR 'N' TO QUIT

HERE'S THE FIRST PHRASE:
MODULAR NON-GRADED PERFORMANCE
? Y
FLEXIBLE SCHEDULING FACILITY
? Y
MODULAR CREATIVE CORE CURRICULUM
? Y
DIFFERENTIATED INTEGRATED STRUCTURE
? Y
DIFFERENTIATED TRAINING ALGORITHM
? Y
TAVISTOCK CREATIVE MODIFICATION
? Y
ABILITY CREATIVE STRUCTURE
? Y
CHILD-CENTERED MOTIVATIONAL GROUPING
? Y
HETEROGENEOUS LEARNING OPEN CLASSROOM
? Y
INDIVIDUALIZED MOTIVATIONAL PROCESS
? Y
ABILITY NON-GRADED PROCESS
? Y
INDIVIDUALIZED NON-GRADED STRUCTURE
? N
COME BACK WHEN YOU NEED HELP WITH ANOTHER REPORT!

READY
```

SATURDAY SEMINARS

A series of one-day seminars for secondary school educators is being offered by the Abacus Computer Corporation in many major cities this winter and spring. The seminars are designed to educate teachers and administrators on the wise and profitable use of classroom computers.

The course schedule includes discussion of basic computing concepts, computers in education, the computer as a problem solving tool, and instructional aids. A registration fee of $60 includes materials and a take-home packet of texts. Courses are scheduled in the following cities: Atlanta (Feb. 23), New Orleans (April 13), Washington, D.C. (April 27), Chicago (May 4), Los Angeles (May 25), Toronto (June 8), and New York (June 22).

For more information write to the Abacus Computer Corporation, Box 1325, Ormond Beach, Florida 32074. Tell them EDU sent you!



DECTAPE LABEL

In EDU #8 we ran a contest for the best DECtape label design. Of all the entries our readers sent, the winning label was a creation of an unknown would-be artist who lives somewhere in the Maynard mill . . . and he (she?) never identified himself!

The most interesting characteristic of this label is not evident until it's placed on a spinning reel of DECtape . . . and the series of lines on the top half of the label spin into brilliant color! Can you guess the colors that belong to each set of lines? Why not cut the label out and try it for yourself?

CAI FOR ELECTRONICS TECHNOLOGY

by James Lockett and Charles McKay
Department of Technology
Lee College
Baytown, Texas

The University of Houston was the scene of a gathering of electronics and instrumentation instructors from Texas community colleges and universities during the week of August 20-24, 1973.

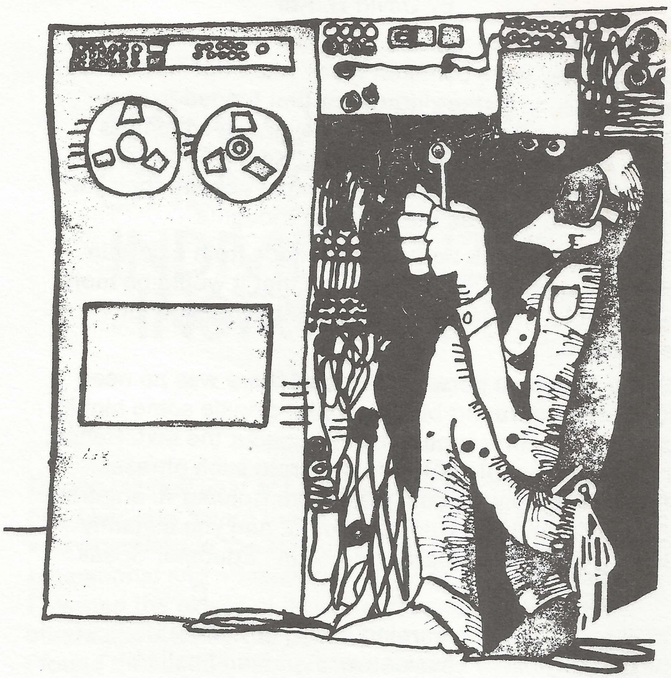
The five day, forty-four hour seminar simultaneously covered three main topics: introduction to digital electronics, lasers and electro-optics, and the development of Computer Aided Instruction modules in electronics technology. Travel and expenses for the participants were provided by the Texas Educational Agency.

Charles W. McKay, Chairman of Technical Education at Lee College, Baytown, conducted the CAI seminar. This portion of the workshop was presented to those instructors who had attended last year's workshop on principles of computer control and had advanced beyond the digital electronics seminar. The session was held in a lecture-lab fashion with the cooperation and support of Digital Equipment Corporation, which provided the seminar with a five-terminal PDP-11/20 computer system and associated BASIC language software and instructional manuals.

The format of this seminar covered systems theory, educational modules, programming in BASIC, and the design and development of CAI modules. The last three days of the seminar were devoted entirely to the lecture-lab construction of modules which the instructors could take back to their own colleges.

During the last three days of the seminar, eighteen BASIC CAI modules were developed and implemented; the modules displayed various electronic circuits with sets of a minimum number of known values necessary to enable the student to solve for the remaining unknown parameters. After the student works three problems correctly under a given set of conditions (the student is not restricted to any number of trials), the conditions are changed, and the student proceeds in this fashion to the end of the module. Each instructor left the seminar with these eighteen prototype modules and some experience in the design of CAI modules to meet their own specific needs.

> Tomorrow's schools must teach not merely data, but ways to manipulate it. Students must learn how to discard old ideas, how and when to replace them. They must, in short, learn how to learn.
>
> —Alvin Toffler



USERS IN CONFERENCE

Several DIGITAL users held workshops in conjunction with the National Science Teachers' Association (NSTA) Northeast Regional Conference on November 29 - December 1 in Boston. For more information regarding the workshop agenda and handout materials, contact the leaders directly.

USING COMPUTERS TO TEACH MATHEMATICS AND SCIENCE
Arthur McMahon, Federal Project Coordinator, Providence, Rhode Island.

An overview of classroom computing in Rhode Island Schools, followed by a demonstration of a PDP-8/E computer system.

INTEGRATING THE COMPUTER INTO A TEAM, SELF-PACED, INDIVIDUALIZED CHEMISTRY COURSE
Phillip A. Crosby, J. Michael Conley, H. Neil Soule, Manny Frangos, Lexington High School, Massachusetts.

A discussion of the chemistry team concept as it is being utilized with the EduSystem 50 computer at Lexington High School. (See article in this issue entitled "The Computer, Chemistry and Individualized Instruction.")

HOW TO TUTOR WITH YOUR COMPUTER
Paul Cauchon, Canterbury School, New Milford, Connecticut

The use of tutorial BASIC programs and an EduSystem 30 in high school chemistry was the topic of this workshop. Mr. Cauchon is the author of *Tutorial Exercises for Chemistry,* recently published by DIGITAL.

ON SIMULATIONS

The benefits of simulation games generally live up to their billing, according to a five-year study by the Center for Social Organization of Schools, The Johns Hopkins University. A review of 26 reports on various simulation game projects shows that they can teach facts, concepts, and relationships as effectively as conventional instruction can. Also they are "at least as good as conventional instruction—possibly better—at influencing students' behavior in a performance test, either real or simulated. And simulation games can sometimes produce marked changes in the expressed attitudes of the players toward persons and activities represented in the game, although these changes may be short-lived." Research by the Center demonstrated that the educational benefits of the games may depend on the academic ability of the students and their socioeconomic status.

WHAT IS NAUCAL?

The National Association of Users of Computer Applications to Learning (NAUCAL) is an organization of user installations whose purpose is to improve the teaching-learning process by influencing the direction, development, evaluation, and dissemination of computer applications to learning. Whether your interest focuses on drill-and-practice, tutorial, simulations, problem-solving, computer-based testing, or any other facet of instructional computer applications—NAUCAL provides a forum for interactive idea exchange.

NAUCAL was founded in 1970 and has recently become a functional chapter of the Association for Educational Data Systems (AEDS). One of NAUCAL's two meetings each year is held in conjunction with the AEDS Convention. NAUCAL sponsors program sessions at that convention.

NAUCAL also sponsors an annual Fall Conference. The 1973 Fall Conference was hosted recently by the Cincinnati Public Schools. The site of the 1974 Fall Conference will be Minneapolis/St. Paul, Minnesota, and will be jointly sponsored in cooperation with the Minnesota Department of Education.

Membership in NAUCAL is on an individual basis at $5.00 per calendar year. Interested individuals should contact:

Mr. George H. Litman, Secretary/Treasurer
Board of Education, City of Chicago
228 North LaSalle Street, Room 430
Chicago, Illinois 60601

Membership in NAUCAL is an investment in the future role of the computer in the teaching-learning process.

Dr. E. Ronald Carruth
President

SIMULATION SEMINARS

The Huntington II Project Staff is now sponsoring on-site seminars for secondary schools and junior and community colleges. These seminars include instruction on the use of computer simulations as learning tools and deal specifically with the use of the Huntington II Simulation Materials.

Seminars vary in length from 1-5 days; two instructors from the Huntington Staff conduct the sessions in two major subject areas. Each attendee receives a complete set of the Huntington II Simulation Materials.

The cost of the Seminar is $150 per day. In addition, a school district must cover instructors' travel, lodging and meal expenses for the duration of the seminar.

For more information contact: Dr. Ludwig Braun, Huntington II Project, State University of New York, Stony Brook, New York 11790.

Tell him EDU sent you!

Christmas in Maynard—Our tree lighted with energy created by the mill's water wheel.

ENERGY CRISIS?

It was hard to fathom the reality of the energy crisis (at least for a moment) this Xmas season at our DIGITAL headquarters plant in Maynard. Because beginning in early December, and continuing throughout the month, the company "sponsored" one of the few outdoor lighted displays in the area—the 18-foot blue spruce pictured here.

Perhaps what made this decoration possible is the same resourcefulness that's made DIGITAL what it is today. Part of the Maynard complex is housed in a 100-year-old woolen mill; a 12-foot water wheel run by water from the large millpond at the rear of the building was the source of energy for the tree lights!

Unfortunately, the water wheel is a little unreliable (at 55 years!) to be put into full-time use . . . but other efforts in a company-wide fuel conservation program are being made to help ease the energy crisis!

APPLICATION STORIES

COMPUTERS AND THE ARTS

DeAnza College's CAI activities involve staff from the art department as well as the data processing division. Currently four teletypewriter terminals linked to the IMSSS PDP-10 at Stanford University are being used to teach computer programming. A grant from the Northern California Computer Network supports research on programming computer graphics and the use of the PYLON language. By the end of summer 1973, courses in design, art appreciation and art history, as well as a program for generating fabric designs, will be available.

From PCC Newsletter,
Vol 1, No 1.

A computer workshop, held last May at Eastern Michigan University, provided the opportunity for artists to work with the school's PDP-10 computer in music composition, visual arts, video and literary applications. Daily sessions dealing with each of these topics were followed by a survey of the computer and its capabilities.

Reprinted from *On-Line,* May, 1973.

THE COMPUTER, CHEMISTRY AND INDIVIDUALIZED INSTRUCTION

by Phillip A. Crosby
Lexington H.S.
Lexington, Mass.

During my first year at Lexington High School (1968-69), I became aware that a DIGITAL PDP-8 computer was operating in the school, serving a variety of educational and administrative needs. That first year I learned the extent of its use and began talking with others about using the computer in chemistry. I found that some teachers had already written FORTRAN programs for chemistry; I translated some into FOCAL during the summer of 1969 and attempted to use them in my classroom the next fall.

I must admit I quickly became discouraged. Many programs still needed to be written. The computer was located about eighty yards from my classroom in a room designed to house only four students at a time. Writing programs was (and still is!) rewarding but time-consuming; helping students with problems at the terminal was impossible because of both the physical arrangement and my teaching methods. I had classes of twenty-four to thirty students, and even though I ran a fairly open classroom, my constant travel between the classroom and the computer detracted from the progress in the classroom. I abandoned the computer about mid-year after succumbing to the immediate problems, but I was still excited about the ultimate prospects that the right setting promised.

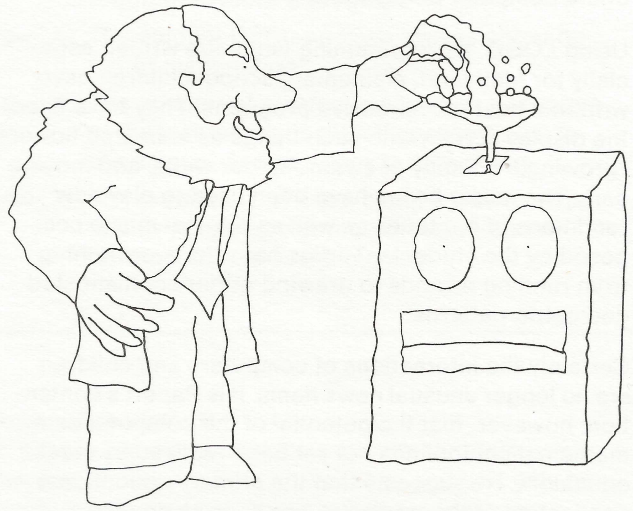
In early 1970, I became part of a movement within the Chemistry Department to improve our methods of teaching. Five of us came to the following conclusions:

1) We must individualize the teaching of chemistry.
2) We must present learning opportunities for all interested students.
3) We, as teachers, were far too isolated from one another; we needed to share our ideas, frustrations, hopes, fears, and special skills.
4) The curriculum must be multi-media and multi-level. The use of texts and lab books had to be reduced by introducing the use of other learning devices.
5) We would need to spend considerable time pre-
etc.); that effort would be worthwhile if a large
paring learning materials (programs, audio tapes,
number of students would benefit.

These conclusions prompted the following actions:

1) We formed a group called the Chem Team[1] and from that time acted as a unit.
2) Aided by a school-financed workshop during the summer of 1970, we were prepared to begin our program in the 1970-71 school year.
3) We adopted an individualized, multi-media, multi-modal approach based on performance objectives.
4) We acquired a terminal in our learning area, a small room off one classroom. Perfect!

At first we were unable to use the computer in any constructive way because we were swamped with other problems. Halfway through that first year we began writing and acquiring programs. The students loved it, and we have been constantly writing and rewriting ever since.



At present we use over 100 programs, about eighty prepared by the Chem Team. Our individualized approach depends on these BASIC programs too:

—Prepare tests tailored to the needs of each student.

—Provide unique experiences for students through simulations and quiz game activities.

—Help students in their understanding of certain lab experiences by performing laborious and difficult calculations, as well as some analyses.

—Check the students' understanding of certain concepts by recalling stored information in response to a student's prediction, and supporting or refuting his assumptions.

The computer at Lexington High School is a PDP-8E, EduSystem 50. It has four DECtape drives (one is used exclusively by the Science Department), a high-speed paper tape reader and a line printer. At present we have twelve terminals on-line; two terminals are at our Team's disposal, three serve the junior high schools and seven serve the remainder of the high school's needs.

Some conclusions we have reached through this experience may be helpful to those preparing to use the computer in the classroom:

1) Sufficient tape storage is a must.
2) A line printer is not a necessity initially, but it has shortened our program preparation time considerably.
3) A terminal must be mobile enough to be in the classroom or adjacent to it if a teacher in a self-contained classroom plans extensive use.
4) Teachers displaying programming talents and interests need to be encouraged; they need private terminal time.
5) Prepared programs are gradually appearing on the market; they can serve as a foundation for a program library.

At the end of the 1972-73 school year, a general questionnaire was completed by 190 students concerning all aspects of their chemistry computer experience. More than 50% of the respondents felt that using the computer in chemistry was worthwhile and that more computer time would have been valuable.

It has been our intention to expose a great many students to the computer on a regular basis. Using the EduSystem 50 as an integral part of our program has accomplished this for us.

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[1] The Lexington H.S. Chem Team includes H. Neil Soule, Manny Frangos, J. Michael Conley, and the author, Phillip A. Crosby.

NEWSWORTHY NOTE

The Millsaps College, Jacksonville, Miss., computer network has received so much publicity in local and state publications lately that it can't go unmentioned! If using press coverage to encourage community and parental support for computer instructional programs interests you, maybe Dr. Robert Shive can offer some advice!

The most recent coverage described the weekly workshops for high school teachers, sponsored by the Millsaps Computer Center this fall. The sessions, which dealt with BASIC programming and computer applications in mathematics and science, were conducted by Dr. Robert Shive, Jr. and Dr. Allen Bishop, Jr., of the computer center. The college's Edusystem 25 is currently servicing Jackson Preparatory and Saint Andrews Episcopal School, as well as Millsaps' own instructional needs.

Supertoys, A New Approach to Learning Mathematics

Many "new products" are interesting—a few are also useful, but only rarely can one be described as revolutionary. This review is longer than most because both the products and the ideas that motivated them may indeed revolutionize the pedagogy of mathematics fundamentals.

Dr. Seymour Papert, the mathematician and child psychologist who is codirector of the Artificial Intelligence Laboratory at the Massachusetts Institute of Technology, has been working to harness the intuitive mathematical ability of children at play to create a computerized learning environment where every student is successful and no one fails.

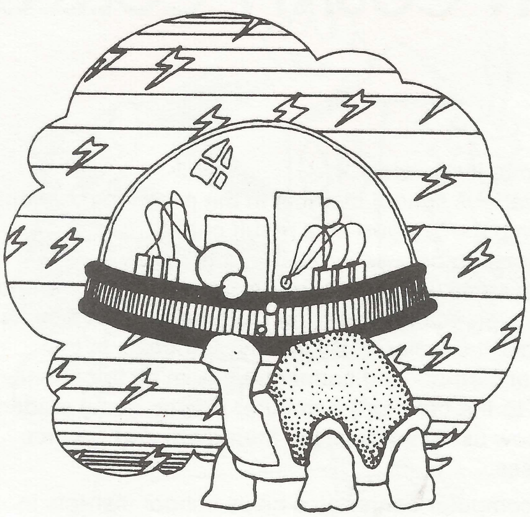
To appreciate the theory of Dr. Papert, one must first understand his permise: The best way to teach mathematics to youngsters is by presenting it as a second language rather than a unique, number-oriented discipline; and the best way to learn a language is to go to a land where that language is the primary means of communication. Dr. Papert suggests that a child who has trouble understanding the number process is often said to display a lack of inherent mathematical ability. However, the French teacher is unable to pigeonhole slower learners in this way, since everyone knows that in France all children learn to speak French. Dr. Papert believes that every child has a similar mathematical intuition. He can, for example, select the proper speed and distance that must be run to catch a baseball. To accomplish this task he must calculate a number of variables both instantly and intuitively. By programming a robot turtle to move across the floor in a certain way, the same child begins to make a formal model of his own behavior. The important point is that the child is instructing the turtle through the computer, in a language of mathematics.

Grade school children learn mathematical concepts with the "Mathland" turtle at the Artificial Intelligence Lab at MIT, Cambridge.

Papert and his colleagues have devised some of the components of what they call "Mathland," an arena where fourth, fifth, and sixth graders of below-average mathematics ability (by traditional standards) play with "supertoys" by communicating with computers in the language of mathematics. Mathland's supertoys range from computerized music boxes that emit notes and rhythms as programmed by youngsters to robotic "turtles" that move along the floor in paths predetermined by the children's computer programs. Typically, a child's excursion into Mathland might begin with an introduction to the computer, most likely by using the robotic turtle to draw geometric patterns on a large paper on the classroom floor. By typing extremely simple instructions on a typewriter-like terminal, first the teacher and the student can command the turtle. The rather remarkable turtle is equipped with "sense organs" that accept electrical signals from the computer, a horn, a light, "touch" sensors, and a pen that can be lowered to trace the turtle's path. Soon the student can learn to write programs that will cause other Mathland supertoys to behave as he wants. He can, for example, choose to use a visual display in which the turtle is represented by a triangle. Several students can work independently with turtles, visual displays, or music boxes, depending on the timesharing capacity of the computer being used.

Using LOGO, a programming language written especially for Mathland, elementary school children have written a host of impressive programs. They have filled the display screen with such things as animated flowers "growing," a family of swans, spider webs, and moving cars. The music boxes have been used to play new renditions of old tunes as well as original music composed by the students. Turtles have done everything from running errands to drawing rather sophisticated geometric patterns.

Certainly the interactions of computers and children are no longer unusual news items. It is Papert's contention, however, that the potential of the computer as a mathematical tool has not yet been realized by most educators. He suggests that the primary educational application of the computer has been to provide students with drill and practice in mathematics fundamentals. In Mathland, the student is allowed to change roles with the teacher. The student can then teach his computer to do whatever he wants, being limited only by his imagination. Hence at an early age, the student can experience a glimmer of the usefulness of mathematics and the potential of the computer. Mathland is not all fantasy, as you might suspect. Dr. Papert's group has been conducting Mathland experiments at MIT for the past three years. During that time portable Mathlands have been established at several New England elementary schools as well as at some schools in England. Mathland programs using the LOGO language can be run on both small and large computers—a PDP-11 minicomputer and a million-dollar DECsystem-10 have both been used. Papert's work indicates that computer size does not have a great effect on the children. However, size must be considered because larger computers permit larger student groups to work at one time. Papert suggests that if a school does not have access to a large computer, it would do well to spend the relatively small amount of money necessary to purchase a minicomputer and the other related equipment.



The other turtle equipment has recently been made available through a newly formed company—General Turtle, Inc. (Really!). General Turtle can supply you with turtle, music box, video plotter, and a controller for all the devices—everything but the computer—for $4,000. If you would rather proceed more cautiously into the world of supertoys, the devices are also available separately.

General Turtle publishes a very highly recommended information booklet called "New Educational Technology." The 60-page first printing of this booklet provides an excellent introduction to the philosophy of Mathland and the goals of its creators. A year's subscription to "New England Technology" costs only $5 and is available from General Turtle, Inc., 545 Technology Square, Cambridge, Mass. 02138.

You owe it to yourself to investigate the work of this innovative group. They may not convert you, but they will indeed give you much to re-evaluate and think about.

Just as the Mathland concept differs from "learn by rote" number instruction, so the results elude standard interpretations for evaluating the mathematical progress of the children. However, qualitative evidence of Mathland's worth can be found in the snowballing enthusiasm of the people—teachers, students, and parents—who have taken part in one or more of Mathland programs, and in the ever-growing number of requests from educators and parents for acceptance in future Mathland projects. Evidence is also reflected in the eager eyes of youngsters watching their computer programs put to use in their own Mathland. Dr. Papert feels that the ultimate accomplishment of the goals of Mathland will "present a grander vision of an educational system in which technology is used not in the form of machines for processing children but as something the child himself will learn to manipulate, to extend, to apply to projects: thereby gaining a greater and more articulate mastery of the world, a sense of the power of applied knowledge and a self-confidently realistic image of himself as an intellectual agent."—Walter Koetke.

Reprinted from *The Mathematics Teacher,* December 1973.

ALL ABOUT PROJECT LOCAL

Project LOCAL, the Laboratory Program for Computer-Assisted Learning, is a non-profit organization serving public and private schools in the Boston area. It is an outgrowth of a three-year federally-funded program established in 1967 to improve mathematics instruction through the use of the computer as a teaching aid. The scope of its activities has been expanded to include computer applications in science and social studies instruction as well as guidance, school administration, and educational research.

Since 1967, the emphasis of the project's offerings has shifted from curriculum development to serving as a linking agency for area schools. Many excellent computer-oriented education materials are being developed in innovative centers around the country; Project LOCAL's role is to bridge the information gap for its member school systems. This is done primarily by means of in-service training courses, consulting, newsletter publication *(LOCAL Link),* and the maintenance of a central lending library of documents, programs, and AV materials.

The LOCAL membership has expanded from the original membership of Natick, Needham, Lexington, Wellesley, and Westwood to include three recent new members: Dedham, Brookline, and Wayland. The member towns are using DIGITAL PDP-8 family computers; the number of users per system varies from 6 to 20. The majority of the systems are disk-oriented BASIC language systems.

For more information about the Project, contact Bob Haven or Pam Ellsworth, Project LOCAL, Inc., 200 Nahatan Street, Westwood, Mass. 02090; telephone (617)326-3050.

VOLUNTEERS FOR LEARNING

The mathematics teachers at Lebanon High School, Lebanon, Pa., wanted to learn more about their EduSystem 20. So they volunteered to take part in a workshop program, consisting of a two-day session at Franklin and Marshall College, followed by three Saturday sessions at the high school. Luther W. Stone, Mathematics Department Co-ordinator at Lebanon High School, conducted the Saturday sessions. Stone currently utilizes the system in computer mathematics and business courses.

COMPUTING AT BURLINGTON COUNTY COLLEGE

Burlington County College in Pemberton, N.J. is one of the fastest-growing educational institutions on the Eastern seaboard. College officials soon realized the necessity for a computer facility that could handle the rapid increase in administrative and academic tasks. The computer center was also planned to be a joint organization providing services on a shared-cost basis for the college *and* the county. After an extensive search, Burlington College selected Digital Equipment Corporation's versatile DECsystem-10 to do the job.

There were three major requirements of the computer system in order to serve both the college and community's objectives:

1. A general timesharing system for both students and faculty.
2. The ability to develop and operate batch-type administrative systems with a particular emphasis on the ability to multi-program.
3. Quick and easy development of a number of on-line data collection and administrative systems, featuring terminals located at work sites capable of retrieving and updating data from centralized files.

DECsystem on Campus

The system's campus duties include admissions, registration, student scheduling and running the library's automated circulation.

Student registration was once a typically massive headache for all concerned. Now every Burlington student is scheduled by the computer and receives a computer-printed schedule for reference. The process is fast and simple. CRT terminals perform the verification process, checking the basic data about each individual registrant. The student then fills out a card and the computer informs him if the classes have space. When a schedule is confirmed the computer prints a copy for the student. Instructors also receive a roster of all students assigned to their classes.

In purely academic areas the DECsystem-10 operates a computer-supported instruction program, a computer-managed instruction plan, a simulations and games program, a student response system and a student testing center.

DECsystem-10 made Burlington County College's library the first computerized system of its kind in the country to serve a two-year institution. The library enjoys automated circulation for more than 30,000 volumes presently on file, and officials say that the DECsystem-10 will catalogue up to one million volumes. The library system is based on a network of four CRT terminals multiplexed through external hardware and wired to the communication controller of the computer. In the course of any given day the system will check books in and out, request lost book cards, request new file entry cards, locate books via accession lists, list all of the books currently being held by any particular student, give the identity of any student holding a specific book, give a daily transaction total and show how "full" the library is.

Community Service

The various school districts in the area are recipients of computer support as a result of the working relationship between college and community. The DECsystem-10 is helping to provide better instruction while significantly lowering the administrative costs of running the schools. By placing terminals in the school districts and connecting them by telephone lines to the college's computer center, many students are now using terminals in their math and science courses.

The computer center also helps school districts in registration and scheduling. The computer supplies the school superintendent with a master schedule and also furnishes each student with a class schedule. A grade reporting package operates from a master file at the college. New grades are fed through a computer terminal in the local school district and transmitted to the college for recording and storage. At the computer center all grades are compiled and tabulated and individual reports are printed. The reports can either be delivered to the school for issuance to students or sent directly to the student's home from the computer center.

An overall view of the heart of the DECsystem 10 computer facility at Burlington County College in Pemberton, N.J.; the computer provides on-line services for the college, for adjacent school districts and for various branches of the Burlington County government.

County Government

With similar ease and thoroughness, the system also serves the needs of the Burlington County government. On a shared-cost arrangement the county receives:

1. A record of personnel files on each of its more than 1,650 employees, including cross registry by date of employment and department, insurance data, and an interface to the county payroll system.
2. Paychecks and explanatory stubs for the entire county payroll, net earnings of employees on a quarterly and year-end basis, quarterly tax reports, W-2 forms for all employees plus a year-to-date social security report, bond report and a longevity breakdown.

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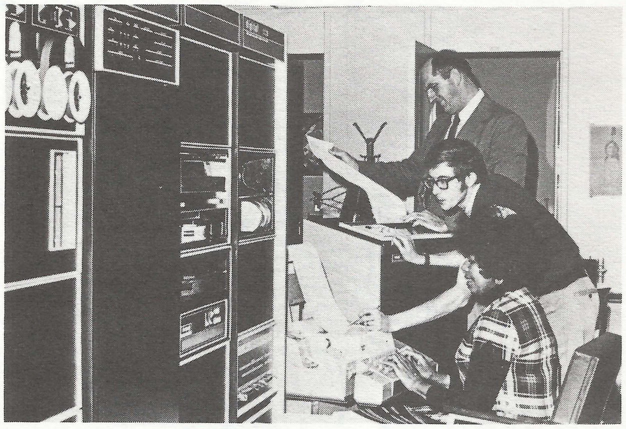
WABASH COLLEGE STUDENT INFORMATION SYSTEM

In addition to its use as an instructional resource, the RSTS-11 system at Wabash College now keeps records on all of the school's students—past, present, and future. Developed under the direction of academic computer center director Dr. James Warden, the system handles all non-fiscal data processing for this liberal arts college of about 800 men located in Crawfordsville, Indiana. The development of the information system had to be sandwiched in with Dr. Warden's other duties, which include teaching physics courses, computer courses, and managing the RSTS system as an instructional resource. The system has an extensive library of instructional software, and is used by more than 80% of the student body at some point in their college careers.

Written in BASIC-PLUS, the information system consists of three major subsystems—student, alumni, and admissions—and several utility programs. The student subsystem provides for registration and the printing of grades and transcripts. Dr. Warden and his staff can produce a completed class list 30 minutes after the information is entered through the computer terminals. The interactive procedure provides instant confirmation of each student's schedule and eliminates the long delays characteristic of batch-oriented systems. The alumni subsystem permits on-line inquiry and updating of alumni files. It also facilitates printing lists and mailing labels by class year, and provides the data needed for sophisticated analyses of donation patterns. The admissions subsystem keeps track of each prospective student who contacts the college, accumulating his credentials until the college makes a final admission decision on the basis of his record.



Using the Wabash RSTS-11 Student Information System at the College's Cragwall Computer Center are (top to bottom) Thaddeus Seymour, President of Wabash; Dr. James Warden, Computer Center Director; and Jasmine Robinson, Staff Assistant.

All the programs in the Wabash College Information System utilize a standard file identification subroutine, and all files are updated via a standard update utility. The purpose of this structure is to permit easy file modification. Many schools will want to carry additional or different information from that provided for in the Wabash files. The program structure chosen by Dr. Warden makes it easy to implement such file modifications without extensive reprogramming.

Wabash has agreed to allow Digital to distribute this administrative software to other interested RSTS-11 (or RSTS/E) users. For distribution information, please address inquiries to Alice Peters, Education Products Group, Bldg 5-5, DIGITAL.

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3. A daily accounting for the county's probation department including daily payments journal, individual accounts histories, master file printout, beneficiary lists, delinquency letter for domestic relations and criminal fines, weekly charge listings, various fines reports and account totals.
4. A complete data bank on all business and industry in the county, compiled for the planning commission.
5. Results of all county elections by candidate, district and town.
6. Payroll processing for the entire county welfare department.
7. Jury lists for all of Burlington County with statistics by town, instant mail juror questionnaires, juror subpoenas, court attendance records and other data.

DECsystem-10 is meeting the objectives set by Burlington County College. The system has 80K words of core memory, over 100 million characters of disk storage, a data communication controller, card reader, line printer and two magnetic tape drives. College officials expect soon to add enough components to the present system to allow for a rapid increase in the number of programs that can be processed by the system at any one time.

SOURCE MATERIAL FOR EDUCATORS

TEACHING MATH WITH GAMES

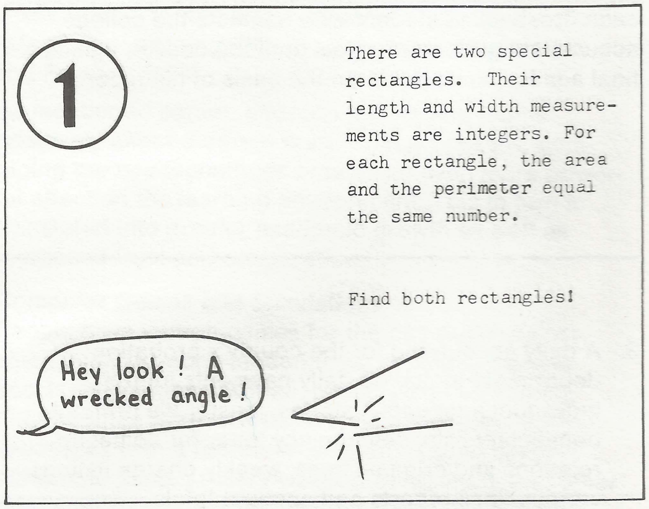
A new volume entitled *Understanding Mathematics and Logic Using BASIC Computer Games,* by David H. Ahl, is now available from DIGITAL. Designed as a companion volume to *101 BASIC Computer Games,* this 60-page book examines a variety of math and logic topics through the use of games. Included in the volume is a short history of games, and definitions and ideas; chapters cover guessing games, logic and inference, coordinates, abstract models and heuristics.

Understanding Mathematics and Logic Using BASIC Computer Games is packed with fresh and exciting ideas that will help you get started quickly in introducing games into your math curriculum. It's available for $1.50 (plus $.50 postage) from the Software Distribution Center, PK1, DIGITAL. Payment must be enclosed. And why not order a copy of *101 BASIC Computer Games* ($5.00) while you're at it?!!

COMPUTER CONVERSATIONS

Two Minneapolis teachers, in their search for suitable problems for computer solution, have designed this collection of uniquely creative BASIC exercises for grades 5-12 mathematics. The product, *Computer Conversations,* is both an exciting and clever execution and a valuable addition to a teacher's computer math resource collection.

Computer Conversations consists of 41 clearly written problems, each printed on a heavyweight colored 5 x 8 card. Each of these Student Cards is fully (and humorously) illustrated; the cards are designed for individual enrichment, small group work, or as weekly project problems. An accompanying Teacher's Guide provides BASIC program solutions, sample runs and comments.



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There are two special rectangles. Their length and width measurements are integers. For each rectangle, the area and the perimeter equal the same number.

Find both rectangles!

Hey look! A wrecked angle!

Computer Conversations Student Card #1

The *Computer Conversations* Student Cards (3.15/set) and Teacher's Guide ($2.15) may be ordered from The Math Group, 5625 Girard Ave. South, Minneapolis, Minn. 55419. Mention EDU!

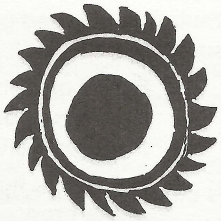
"ION HUNT" A STUDENT FILM

A student research project was undertaken at the Eastdale Collegiate and Vocational Institute (Oshawa, Ontario) in June, 1972; the project resulted in the building of a simple, single-focussing mass spectrometer. The spectrometer became operational in June, 1973, and plans are underway to use the instrument to demonstrate basic ideas to senior physics and chemistry students in the future. Students at Eastdale use a DIGITAL PDP-12 computer at Durham College (Ontario).

"Ion Hunt" is an 8mm. color, sound film which describes the project. The film was produced and directed by William Dorko, a chemistry teacher at Eastdale; students handled the photography, animation and editing tasks. The purpose of "Ion Hunt" is not to show the process in building the spectrometer, but rather to convey the spirit of scientific research to non-scientists and at the same time, convey the importance and the interrelationships of art and science.

For more information about "Ion Hunt" contact Mr. William Durko, Chemistry Department, Eastdale Collegiate and Vocational Institute, 265 Harmony Road North, Oshawa LIG6L4, Ontario, Canada. Mention EDU!

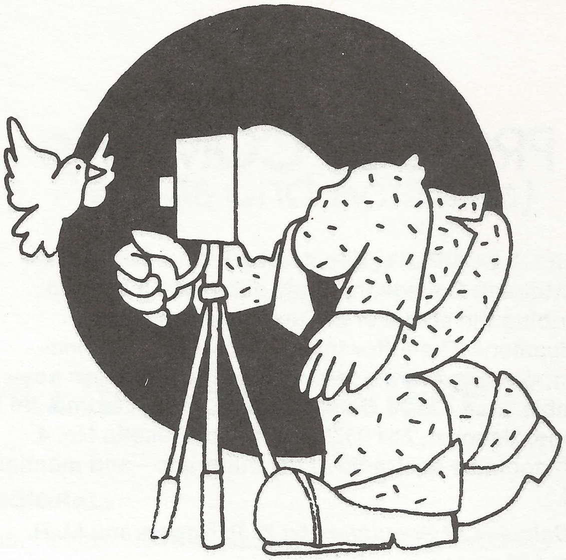
THE SOURCE CATALOG



The Source is a wonderful newsprint catalog which contains descriptions and reprints of twenty-four curriculum packages. Delightfully innovative, many of the packages have been written for the secondary level (some for elementary classes) and are most applicable to social studies, economics, journalism, science and humanities. The packages vary in form from resource workbooks to experiments and A-V programs.

Two of *The Source* curriculum sets that may be particularly applicable to courses in computer familiarity and problem solving are entitled, "Technology and Social Change" and "The World's Greatest Problem Solving Machine—You."

To obtain more information and a personal copy of the catalog write to *The Source,* P.O. Box 103, Soquel, CA 95073. Yes . . . please mention you-know-who!



HUNTINGTON IN REVIEW

For those readers who have just joined us, the following Huntington II Simulation Modules are now available. Watch the next issue of EDU for more announcements!

Biology

GENE1:	Simulates the inheritance of genetic traits.
LOCKEY:	Studies the lock and key model of enzyme action.
MALAR:	Students control malaria epidemic.
POLUT:	Simulates the pollution of a lake, river or pond from various types of waste.
POP:	Models of gypsy moth population growth.
STERL:	Investigates the effectiveness of insect control by means of male sterilization and pesticides.
TAG:	Investigates the size of a wild life population through tagging and recovering.
USPOP:	Simulates a human population study.

Physics

CHARGE:	Determines electron charge by simulating Millikan's oil-drop experiment.
SLITS	Young's double slit experiment, showing light interference patterns.

Social Studies

ELECT1-2-3:	Three programs that model campaign strategies and decision making.
MARKET:	Game engaging two companies in one-product competition.
POLICY:	As members of various pressure groups, students formulate national policy.
POLSYS:	As various community members, students influence city government policy.
SAP:	Statistical analysis package for survey projects.

To obtain a Huntington II Brochure and order form, write to Communications Services, PK1, DIGITAL.

PROJECT COMPUTe

PROJECT COMPUTe, directed by Arthur Leuhrmann at Dartmouth College, recently published a bulletin describing the status of the texts that are under development. The following computer-oriented materials, designed for undergraduate level use, are now available from Kiewit Computation Center, Dartmouth College, Hanover, NH 03755. Write for Bulletin No. 4 which contains abstracts of the materials—and mention EDU!

The Calculus of Population by K. P. Bogart and M. R. Vitale. 180 pages.

An informal, applications-oriented introduction to the theory of calculus which incorporates the computer to help students understand concepts and obtain problem solutions. The text is designed either as a supplementary text for an elementary functions course or as an introduction to calculus. It assumes a background in high school algebra and exposure to BASIC or related languages.

An Introduction to Environmental Measurement and its Descriptive Analysis by Computer by G. F. Estabrook. 85 pages.

Designed to serve as a guide to methodology in the investigation of environmental variation, this exposition is based on the contention that method is learned through its practice; hence, it assumes active student involvement. Three specific data analysis techniques are discussed to exemplify the role of data analysis in scientific methodology. Significant use is made of the computer in analysis according to these techniques.

Physics Tutorial Problem Workbook by J. L. Jones. 100 pages.

This workbook is designed for use by the student in conjunction with a timesharing computer. It consists of 50 tutorial problems and related diagrams and is designed to augment instruction in undergraduate level general physics. Half of the problems deal with mechanics; the others deal with topics in electricity and magnetism. Each BASIC tutorial is fully documented.

Place: A Computer Manual in Introductory Geography by V. H. Malmstorm. 170 pages.

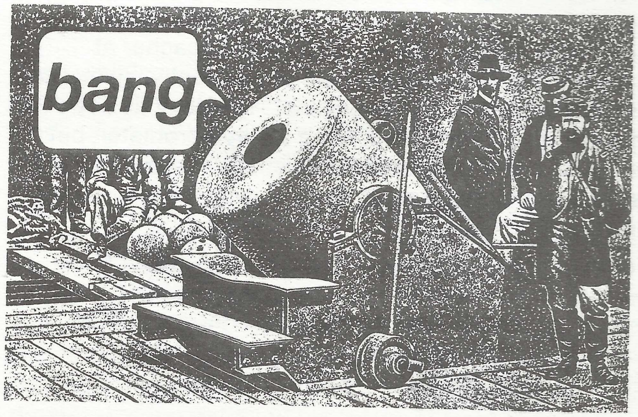
This volume examines several topics related to the rise of the computer in geography including:

- computer mapping
- map analysis
- physical geography (computer applications)
- cultural geography (computer applications)

> Computers can do so many things that only people's imagination limits what they can do.
>
> —Claude DeRossi

CIVIL WAR

The CIVIL program, written by L. Cram, L. Goodie and D. Hibbard from Lexington H.S. (Mass.), simulates fourteen Civil War battles. CIVIL places the user in the confederate commander's position and allows him to make decisions regarding the amount of monetary resource to be spent on salaries, food, ammunition and the strategy to be employed. The program specifies the number of men and amount of money available to each side, as well as the rate of inflation affecting the money, the state of morale for the Confederates, and the offensive or defensive position.



This simulation is based on some important relationships such as:

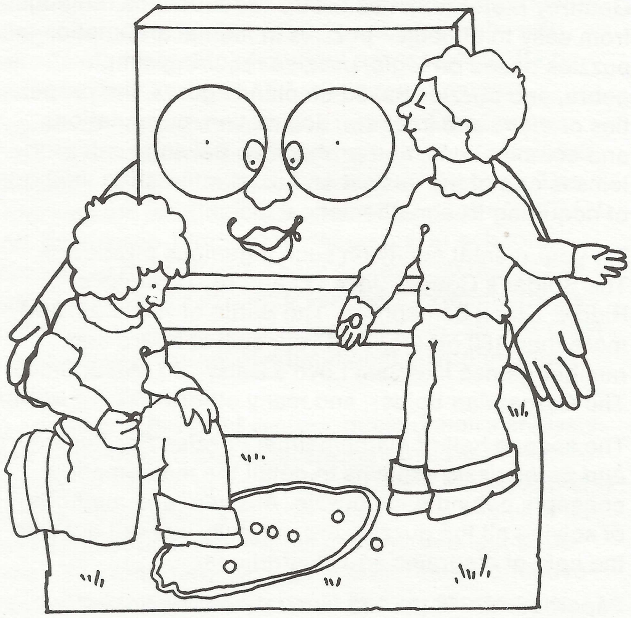
Men:	Based on actual battle figures; numbers of men based on morale and success in the previous battle.
Money:	Not actual figures, but relative to the rest of the program; may be spent on salaries, food, and ammunition or saved for future battles.
Inflation:	Fluctuates based on success of previous battle.
Morale:	Based on amount of money spent on food and salaries and success in last battle.
Strategy:	Four choices for both offense and defense; computer randomly chooses a strategy for the North.
Casualties:	Based on actual figures and determined by sufficient ammunition, equipment, and men.
Desertions:	High if morale is low.

CIVIL is a very suitable simulation for secondary level courses in American history. It has been effectively used as a group activity session, even by students who have not previously studied the war in class. BASIC language paper tape and documentation for CIVIL can be obtained from the DECUS Library (Order No. *DECUS 8-332,* $1.00), PK3, DIGITAL.

REMEMBER PLAYING MARBLES?

Marbles? Maybe you think we've lost ours! But since the feature of this issue of EDU is "Games and Simulations" it seems fitting to mention a new volume about old games entitled *The Great American Marble Book* by Fred Ferretti. It fully describes and illustrates more than forty marble games and poses some interesting possibilities for the computer gamers in your classroom (or on your faculty!)

The *Marble Book* (128 pp., $2.50) and many other equally clever volumes for school and home use are published by Workman Publishing Company, 231 East 51st Street, New York, N.Y. 10022. Write for a catalog and mention EDU!



GRASSLANDS

Grasslands, an ecology simulation game based on chapters in *The Web of Life* by John H. Storer, is a simplified version of Storer's model. This simulation game, based on card-deck logic, demonstrates the effect that the introduction of cattle has on the natural balance of three prairie life forms: grass, grasshoppers and meadowlarks. Since grasshoppers feed on grass, meadowlarks feed on grasshoppers and meadowlarks nest in tall grass, this simulation poses interesting problems related to this natural cycle. The goal is to determine the maximum population of cattle that can exist in the grasslands before an ecological catastrophe will occur.

Grasslands was designed by Michael Chester and appeared in the November 1972 issue of *Simulation/Gaming/News.* For more information about *Grasslands* write to Vort Corporation, Palo Alto, California 94301. Mention EDU!

DRUG ABUSE GAME

Drug abuse and the need for an educational program to help combat drug abuse is a salient issue for educators, government officials, and parents alike. The problem is embedded in an attitude or subculture that simply doesn't respond to law enforcement or exhortation by parents or others interested in the welfare of young people.

Many teachers and adults are seriously concerned with drug abuse problems, but too often do not possess either the necessary factual information about drugs or an understanding of the psycho-social factors leading to drug abuse. Futhermore, many professionals are so frightened by the danger of drug abuse that they can only communicate to youth about drugs in a punitive, didactic manner which often serves to alienate the young.

The lack of dialogue with the young and the blind fear of drug abuse is an impediment to progress in prevention, intervention, treatment, and rehabilitation. The goal of *The Social Seminar,* of which "Community at the Crossroads: A Drug Education Simulation Game" is a part, is to inform and sensitize teachers and all adults in an effort to remove stereotyped views about drug abuse, thus preparing the way for the adult community to be constructively helpful in prevention, intervention, treatment, and rehabilitation.

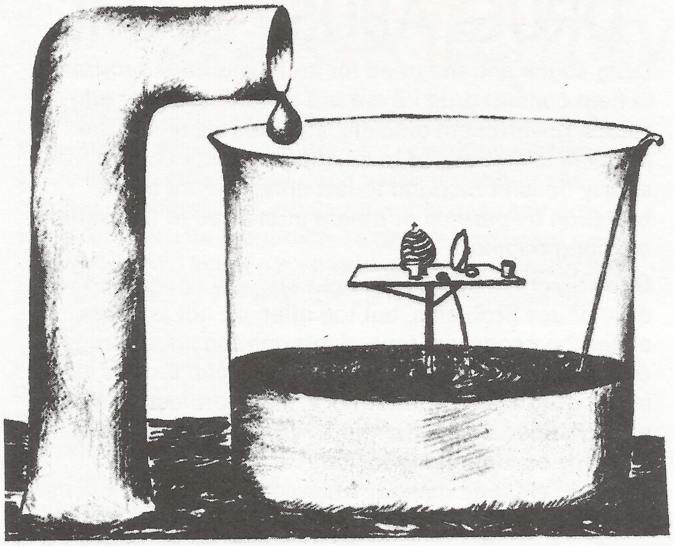
This is a role-playing, non-computerized game. It is intended for 20 to 40 participants with 32 the optimum number. It can be played by all students or by a mixture of teachers, students, community officials and/or parents. Varied backgrounds, interests, and attitudes of participants is most effective for playing the game.

Available from Health Services and Mental Health Assn., National Institute of Mental Health, Washington, D. C. 20514.

COMPUTRONICS

Students enjoy freedom of the press once again in this new and highly innovative computer newsletter. Edited by Gabe Salton, student at Niles West Township High School, Skokie (IL), *Computronics* is packed with articles, editorials and sometimes outlandish ideas for classroom computing!

If you'd like to sample the creative outpouring of fellow EduSystem users (Niles has an EduSystem 25) why not write to: *Computronics,* c/o Gabe Salton, Niles West Township High School, Skokie, Illinois 60076. And mention EDU!



GAMES FOR THE SCIENCE CLASSROOM

Not all effective educational games use the computer. In fact, most of them don't. A recent article entitled "Games For The Science Classroom," in *The Science Teacher,* April, 1973, described 14 such manual games. The authors, Rodney Doran and William Watson, begin with a definition of games and a statement of objectives that can be attained by using them, followed by a discussion of the uses and limitations of classroom games. They describe and evaluate 14 representative games related to science instruction, including:

Dirty Water
Extinction
Elements
The Game of Farming
Nobel Prize

They conclude that most of the commercially available games have quite complex rules and require considerable time to play. These factors, coupled with their high purchase price, lead to the recommendation that they should be considered primarily for small group activities rather than for whole-class use. Nevertheless, games seem to have some distinct advantages because students can:

a) be stimulated to go beyond the required materials of study, thereby expanding the scope of the curriculum.

b) understand better some of the seminal ideas of abstract, complex concepts.

c) learn that conceptual and factual knowledge is not only valuable in its own right, but even more valuable when used as a tool for reaching a goal.

A comprehensive list of references as well as sources for all the games are included in the article.

If your library doesn't have the April, 1973, issue of *The Science Teacher,* send $1.70 to:

National Science Teachers Association
1201 Sixteenth Street, N.W.
Washington, D.C. 20036

MATHEMATICAL PUZZLES FOR BEGINNERS & ENTHUSIASTS

High entertainment value makes this book by Geoffrey Mott-Smith extremely desirable for anyone who enjoys puzzle-solving and mental gymnastics. It will provide hours of fun and amusement, as well as fascinating tests of your logic and ingenuity.

Geoffrey Mott-Smith has set up 188 problems ranging from easy to difficult—puzzles in mental arithmetic, puzzles based on logic, puzzles requiring simple algebra, and puzzles based on plane figures, the properties of digits and integers, decimation, permutations and combinations, and probability. Solving such problems is one of the easiest and most interesting methods of acquiring true mathematical insights.

Try your mental agility on such ingenious puzzles as The Spider's Cousin, Jack O'Lantern, Tartaglia's Riddle, Clock Semaphore, The Battle of Hastings, and more than 180 others. Test your skill at board and number games like Sam Loyd's Daisy, Go Maku, Salvo, The Carpathian Spider, and many others.

The second half of *Mathematical Puzzles For Beginners and Enthusiasts* explains in detail the mathematical concepts behind each puzzle. Answers and methods of solving all the puzzles are carefully worked out with the help of diagrams and illustrations.

Paperbound, 248 pp, 135 illustrations. Available for $1.75 plus .50 postage and handling from:

Dover Publications, Inc.
180 Varick Street
New York, NY 10014

Incidentally, *101 Puzzles in Thought and Logic* mentioned in EDU #8 now costs $1.35 from Dover, but is still more than worth it. Ask for Dover's catalogs of books on mathematics, puzzles, games, and recreations. They have scores of excellent and very economical books.

> We seem to have an abiding faith in books and teachers and free hours, and in the little red schoolhouse as grandfather knew it. Many of us seem to believe that education is something that should not change. There is evidence, however, that we are standing on the edge of an educational revolution and it is just a matter of time before something pushes us over and into the 20th century.
>
> —John H. Sandberg

BOOK REVIEWS

The Guide to Simulations/Games for Education and Training, by David W. Zuckerman and Robert E. Horn, Second Edition, Information Resources, Inc., P.O. Box 417, Lexington, MA, 1973. $15.00

This second edition of *The Guide to Simulations/Games for Education and Training* is a comprehensive volume which contains descriptions of over 600 programs for a wide variety of subject areas. Included are chapters on introducing simulations into course curricula, writing original simulations and games, and introducing these materials to students, teachers, and parents by demonstration.

Music by Computers, by Heinz von Foerster and James W. Beauchamp (eds.), Wiley-Interscience, NY, 1969. $16.00

Music by Computers is an account by scientists and musicians who have contributed to the development of computer applications for the analysis and synthesis of sound. The book contains articles that deals with programs and systems, algorithms in composition and aesthetics.

Man and the Computer, by John Kemeny, Charles Scribner's Sons, New York, 1973.

Written for both the layman and the computer-knowledgeable, *Man and the Computer* describes computer applications for management, education and the home, outlines the concept of timesharing, and traces the history of computers. In addition, the book examines the possibilities for the computer's role in forecasting and understanding world conditions and problems.

The Computer: How It's Changing Our Lives, by Joseph Newman, Ed., U.S. News and World Report, Washington, D.C., 1972. $2.95.

An excellent handbook for incorporation into a computer familiarization course, *The Computer* offers an up-to-date survey of computers and their applications. Designed to provide an understanding of modern technology to the layman, this book deals with the computer's role in medicine, government, business, education and society.

SIMULATION/GAMING BULLETIN

"Educational Simulation/Gaming," an ERIC paper by Paul A. Twelker and Ken Layden, is a lightly written but highly informative bulletin which analyzes the characteristics of non-simulation games, planning exercises, and interpersonal simulation games. It also provides annotated references and lists some of the nationally recognized centers of activity in simulation/gaming.

The bulletin is available from:

ERIC Clearinghouse on Media and Technology
Stanford University
Stanford, CA 94305

SIGCUE BULLETIN

A must publication for everyone interested in computers in education, the *Sigcue Bulletin* is published quarterly by the ACM Special Interest Group on Computer Uses in Education. Each issue contains reports, technical notes, opinion, and latest reviews of new publications and educational materials. So do yourself a favor this year. For the best up-to-date reporting on what's happening in the world of educational computing, treat yourself to a subscription to the *Sigcue Bulletin!* Send $6 (non-ACM member) or $4 (member) to: *ACM Sigcue Bulletin,* A. Kent Morton, Editor, Kiewit Computation Center, Hanover, N.H. 03755. Be sure to mention EDU!

SIMULATION GAMING NEWS

We couldn't resist the overwhelming temptation to mention it again! *S/G/N* is an informative newspaper, published five times a year, which deals exclusively with the topics of simulations, models and games. The contents of every issue range from simple "parlor" educational games to complex, sophisticated computer simulations. In addition, *S/G/N* has thorough coverage of simulation and gaming projects and articles written by noted authorities in the field.

If you'd like to keep abreast of the latest and greatest happenings in this rapidly growing field, subscriptions may be obtained ($4 per year: cash only) from Don Coombs, *S/G/N,* Box 8899, Stanford, California 94305. Mention EDU!

> "There is a way to do it better—find it."
> —Thomas A. Edison

FOUR NEW CLASSROOM GAMES

Your EDU editors recently had the chance to play and evaluate four new classroom games (manual variety). All four are available from:

Houghton-Mifflin Co.
110 Tremont Street
Department M
Boston, MA 02107

The Pollution Game ($9.00)

This game allows players to simulate the progressive contamination of our environment and then try to reverse the contamination to preserve the environment. During the game, players will experience the antagonisms and frustrations of trying to change technology and social behavior. Players will have a chance to design their own strategies to solve the pollution problem.

The Pollution Game should help students understand how their community functions. The players take the roles of influential citizens, make decisions, and initiate actions as if they were in the real-life situations simulated by the game.

Students should realize by the end of the game that solving pollution problems requires knowledge, initiative, cooperation, and usually, money. Without serious attention the problems only get worse.

The Planet Management Game ($12.00)

What projects would you carry out to make the earth a better place to live during the next five years? What results would these projects have? Obviously we can't conduct experiments with the whole earth. However, it is possible to simulate conditions like those on earth using *The Planet Management Game.*

Players become managers of the imaginary planet Clarion and set out to improve its living conditions. They have a budget and can choose among various projects to develop Clarion. They also have a deck of perforated cards that act as a "cardboard computer." When they are used with the data booklet, the cards produce realistic data that enables students to "observe" the results of their management decisions.

The game begins on Clarion in the year 2,000 A.D. and runs for 50 Clarion years. But actually this is a computer-designed simulation of conditions on planet earth. By playing the game, students learn that people's lives are affected by many complex factors, including population growth, food supply, income levels, and the quality of their environment. Attempts to manage these interrelated factors may have surprising and undesirable results. For example, a project that increases income levels may also cause pollution.

Certain conditions inevitably develop on Clarion: it tends to become overpopulated and the environment deteriorates. In this way the game has obvious parallels with the current conditions on earth. Students are encouraged to recognize these parallels and thus understand some of the consequences of man's activities.

The Mouse in the Maze

The Mouse in the Maze helps students develop their ability to conduct scientific inquiries; they also learn how to study learning behavior. Learning can be studied scientifically only by defining a specific task or problem given to the subject.

Ideally, a learner's performance can be measured objectively to give quantitative data. However, kinds of learning take place over long periods of time and involve subtle changes in behavior or beliefs. Such learning is not easily studied in experiments or picked up in tests.

In *The Mouse in the Maze* students manipulate a set of punched *simulator cards* and printed *data cards* to obtain realistic experimental data. These cards enable the students to answer their own questions or test their own hypotheses about how animals behave in a maze.

The Redwood Controversy ($7.00)

Expository prose at its best can only suggest the dynamic, complex nature of public issues. But through role-playing, students can actually participate in them. An important bonus is that students also learn how to bargain, compromise, and negotiate to resolve problems.

Land use problems have conflicting ecological, sociological, and political components. *The Redwood Controversy* is a role-playing game designed to help students understand the issues involved in environmental planning. Students act out the parts of witnesses and United States Senators. Each witness is an important citizen with a special point of view on the park proposals. Each of the Senators gets a different role that shows his personality and how his supporters feel about the park issue. The classroom will be turned into the Senate Chamber, to conduct a Senate hearing to decide whether to establish a Redwood National Park.

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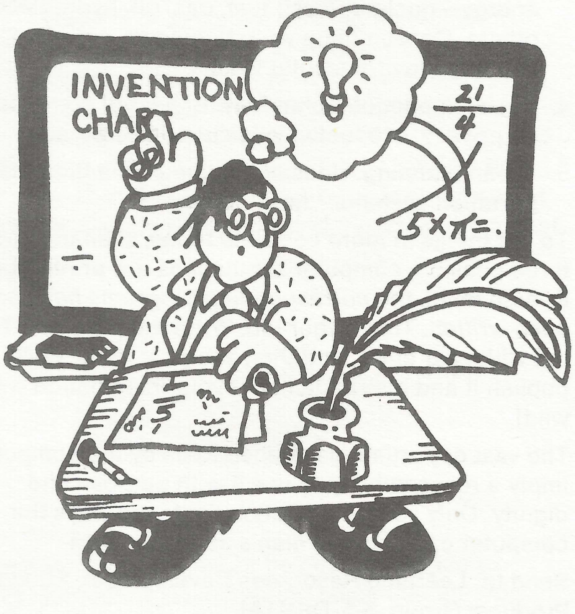
IDEAS AT WORK



THE BINARY CARD GAME

This game, designed by Peg Pulliam of Lexington, MA., is used to teach elementary school students the concept of the binary number system. EDU thanks Peg for sharing her ideas with our other readers!

MATERIALS: Five code cards (12 x 18), labeled as shown in Figure 1.

Thirty-one computer cards (3 x 5 or 5 x 8), each numbered from 1 to 31 on the back; the front of each card contains 5 columns, labeled from E to A.

The binary code is notched (for 0) and punched (for 1) according to the decimal equivalent on the reverse side of the card. See Figure 2.

A large household nail or pencil

E	D	C	B	A
16 24	8 24	4 20	2 18	1 17
17 25	9 25	5 21	3 19	3 19
18 26	10 26	6 22	6 22	5 21
19 27	11 27	7 23	7 23	7 23
20 28	12 28	12 28	10 26	9 25
21 29	13 29	13 29	11 27	11 27
22 30	14 30	14 30	14 30	13 29
23 31	15 31	15 31	15 31	15 31

Figure 1

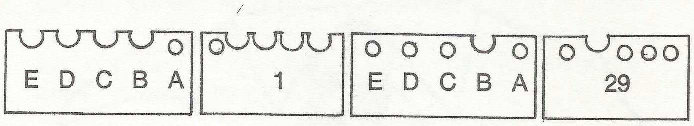


Figure 2

PLAYERS:

Computer (teacher or student)
Class leader

HOW TO PLAY:

The code cards are placed (E on left) on the blackboard ledge, and the computer cards are stacked in a pile (in the same direction!). The class leader chooses a student to guess a number between 1 and 31. This number is secretly recorded and shown to the class, but NOT to the computer.

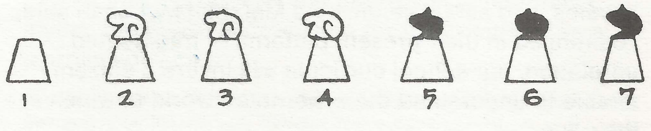
The computer asks the class if the secret number is on code card A. If *yes*, the computer writes a *"1"* on the blackboard above A-card and then pushes the nail or pencil through column A in the stack of computer cards. The computer shakes the pile of cards; all those *cards that fall out* are placed on the desk and the game continues using the remaining cards.

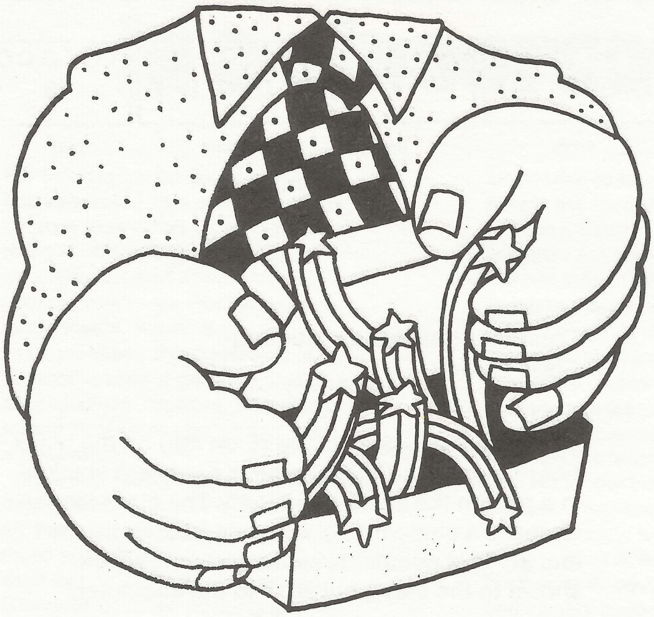
If *no*, the computer writes a *"0"* on the blackboard above A-card and pushes the nail or pencil through column A in the stack of computer cards. The computer shakes the pile of cards; all those *cards that do NOT fall out* are placed on the desk and the game continues using the cards that did fall out.

The same procedure is followed for columns B, C, D, and E; at the end, only one card will remain. And that card contains the secret number!

PROBLEM CORNER

We have been training our six EduFrogs to do a new trick. When placed on glass tumblers, as shown below, they change sides so the three black ones are to the left and the white ones at the right, with the unoccupied tumbler at the opposite end—#7. They can jump to the next tumbler (if unoccupied), or over one, or two, frogs to an unoccupied tumbler. The jumps can be made in either direction, and a frog may jump over his own or the opposite color, or both colors. For example, four successive jumps may be like this: 4 to 1, 5 to 4, 3 to 5, 6 to 3. Can you show how they do it in 10 jumps? Can you write a program to solve the problem?





THE IDEA BOX

CALL FOR SIMULATION PROGRAMS

Psychologist Herbert Gerjuoy of the Human Resources Research Organization said recently, "The new education must teach the individual how to classify and reclassify information, how to evaluate its veracity, how to change categories when necessary, how to move from the concrete to the abstract and back, how to look at problems from a new direction—how to teach himself. Tomorrow's illiterate will not be the man who can't read; he will be the man who has not learned how to learn."

Such education starts with books but goes on to include all kinds of other activities; activities in which students get involved with doing, manipulating, making decisions. Some of the most important of these activities are computer games, models, and simulations. Many are available today but many more good ones are needed.

Particularly needed are games that relate to more than one subject area. All too often we think in terms of teaching individual subjects. But the world isn't composed of isolated events; the world is a fabric of interrelated facts. Consequently, for realism and maximum value, games should relate to all the key aspects of an issue even if it involves mathematics, physics, and social studies. As Marshall McLuhan said, "continued in their present patterns of fragmented unrelation, our school curricula will insure a citizenry unable to understand the cybernated world in which they live."

Games are especially needed in the following areas:

1. Alternatives of the future. The linking of technological events and social change.
2. Value systems, value clarification, processes of valuing.
3. Energy resource management. Alternative sources of energy—nuclear, fossil fuel, gas, oil, hydroelectric, others. Consumption vs. rationing vs. spiraling costs vs. environmental issues.
4. Social impact of technology. Impact of computers on privacy, productivity, leisure time, the arts.
5. Urban planning. Housing, community action, transportation systems, "new" towns.

To put things in more concrete terms, scenarios for three possible computer simulations are printed below. Bear in mind, *the corresponding programs have not been written.* That's your job. Write the program. Try it out with your class, and then submit it to us. We'll publish it and distribute it. Let your imagination run wild!

The vast opportunities opened to us by the computer imply a responsibility to use it with purpose and dignity. Only your imagination limits the ways the computer can improve man's ability to learn.

Send to: Learning Resources Development, Education Products Group, 5-5, DIGITAL.

Flood

In this interactive simulation, the student is in charge of a flood control center along the Missouri River. He is faced with the possibility of a flood occurring because of heavy winter snows and a late spring runoff or because of much heavier-than-average rainfall. Based on information from previous floods and near-floods and his own judgment, he must recommend to the communities in his zone of control to evacuate, sandbag, or sit tight. He must predict crest levels and he must decide whether or not to divert water through one or two alternative channels. Each action has a cost attached, in particular:

Evacuation (6 communities)	$50,000 per day due to lost business per city
Sandbagging	$10,000 per day per city
Do nothing	$0
Water diversion	$500,000 due to increased erosion
Flood	Varies with seriousness of flood

If a flood occurs, there are two possible costs, one due to property damage, the other due to loss of human life. There are all kinds of trade-offs. For example, a flood that crests at 16 feet will be least damaging to a community that has sandbagged to a height of 14 feet, more damaging to a community that has evacuated (property damage) and most damaging to a community that has done nothing (property damage and lives).

Salt

This model simulates control of snow and ice on the roads of a community in the northern half of the U.S. The student is the town mayor and must decide on a method of snow and ice control. He has a number of alternatives:

Action	*$ Cost*	*Result*
Do nothing	0	Loss of lives, loss of business to the community, mayor may be impeached if it's a bad winter.
Sand and gravel	Medium	Slightly better than nothing, big cleanup in spring.
Salt	Low	Good road control but progressive contamination of ground water supply.
Plow	Medium	Fair control but requires more equipment.

Two or more alternatives can be combined. In addition, the mayor must contend with other variables such as petitions from the League of Women Voters against the use of salt, petitions from the school bus drivers for rapid snow removal, threats from DPW workers to strike during the next snowstorm if they don't get a raise, and pressure from taxpayers not to raise taxes.

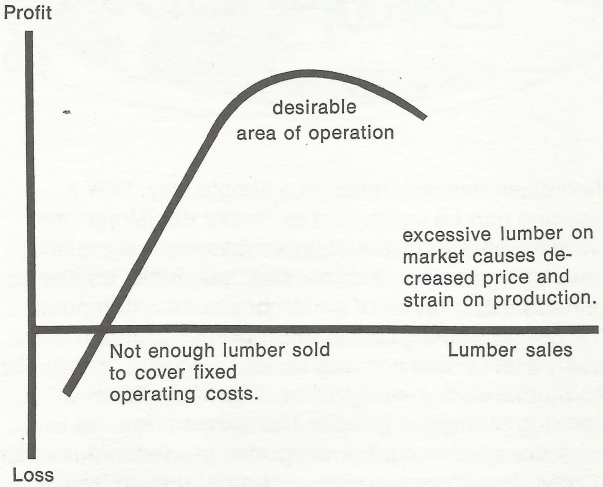
Timber

This computer model simulates the timber resources of the State of Oregon. The 40,000 square miles of forest land (less than 10% of which is commercially harvested) produces 7 billion board feet of lumber annually worth well over $300 million.

As general manager of "Warehouser," the student must decide how much acreage to harvest, how much to reseed, how much to open to public recreational access (hunting, fishing, etc.) and how much additional land to buy. He must also decide how much to spend on public relations and what to spend it on.

Some of the variables he must contend with are forest fires started by lightning and campers, public pressure to lower harvests and preserve the forests, pressures from hunters to open more land to public access and, of course, the pressure to make a profit.

This is not a marketing game; consequently, the price and market variables are fairly simple.



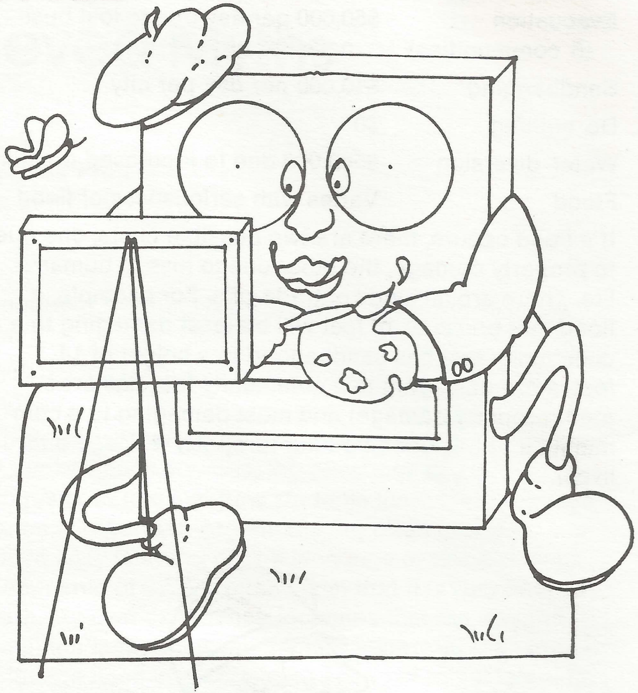
> Computing is not an esoteric or specialized activity; it is a versatile tool useful in any work with a factual or intellectual context. Computing is becoming almost as much a part of our working life as doing arithmetic or driving a car. If the deficit in educational computing is not made up quickly, millions of students who will have attended (these) institutions in the 1970's will be poorly prepared for the world of the 1980's and 1990's.
>
> —President's Science Advisory Committee 1967

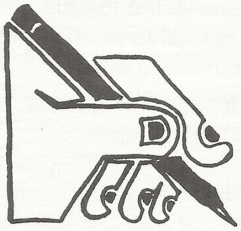
PORTRAITS: COMPUTER-STYLE

The age of technology has brought some amazing capabilities to our lives—and among those is the ability for "everyman" to be a portrait painter! A color photograph of the subject can be computer-produced and packaged into a paint-by-numbers kit (which you, the artist, paint!).

The process involves reshooting the original photo onto 70mm. film which is then analyzed by a scanner; a computer translates this information into 48 oil colors while a computer-controlled laser sketches and labels the "canvas" (16 x 20 size). Your painting kit includes the "canvas," paints, instructions and a practice panel —all for about $20.

Write to: Personal Paintings, Box 123, Toledo, Ohio 43695. Mention EDU! And special thanks to the *Comp Randomly Newsletter* and author Steve Wood for the information contained in this article.





PROGRAM OF THE MONTH
HEXAPAWN: A GAME YOU PLAY TO LOSE

Hexapawn demonstrates, in a simple way, how a machine can be instructed to "make decisions" and avoid repeating past mistakes. *Hexapawn* is a game you play against a machine. The "machine" can be a gameboard, a series of match boxes, or a computer. The object of the game is to program the machine so that it won't make a wrong move . . . so that, eventually, the machine wins every game. The trial-and-error teaching technique used in *Hexapawn* is similar to more complex computer programming techniques used to solve inventory management problems, to train business managers in decision making, and to gain new insight into human learning processes.

The game of *Hexapawn* and a method to learn a strategy for playing the game was described in "Mathematical Games" in the March 1962 issue of *Scientific American.* The method described in the article was for a hypothetical learning machine composed of match boxes and colored beads. Another manual version of *Hexapawn* uses a gameboard, pennies and a spinner. This is available free (in quantities of 1 only) from:

Special Communications Program
IBM Corporation
Armonk, New York 10504

Hexapawn has also been programmed for various computers. One version, for RSTS, called HEX appears in *101 BASIC Computer Games,* and is reprinted on the following page. It was written by Jeff Dalton, Northfield-Mt. Hermon School, Northfield, Mass.

The program learns by elimination of bad moves. All positions encountered by the program and acceptable moves from them are stored in the array P$ (I). When the program encounters an unfamiliar position, the position and all legal moves from it are added to the list. If the program loses a game, it erases the move that led to defeat. If it hits a position from which all moves have been deleted (they all led to defeat), it erases the move that got it there and resigns. Eventually, the program learns to play extremely well and, indeed, is unbeatable. The learning strategy could be adapted to other simple games with a finite number of moves (tic-tac-toe, small-board checkers, or other chess-based games).

For complete playing directions, respond YES or Y to the question, INSTRUCTIONS?

HEX was written is BASIC-PLUS for DIGITAL RSTS-11 and RSTS/E systems. HEX uses string functions and concatenation extensively. Also, the symbol "!" equals REM and "&" equals PRINT. ⟶

PROGRAM LISTING

```
1 ! BY JEFF DALTON, CLASS OF '74, NORTHFIELD MOUNT HERMON SCHOOL
2 ! THIS PROGRAM PLAYS THE GAME 'HEXAPAWN' BY A METHOD OUTLINED IN
        'MATHEMATICAL GAMES' IN MARCH 1962 SCIENTIFIC AMERICAN.
3 ! THE PROGRAM LEARNS BY ELIMINATION OF BAD MOVES. ALL POSITIONS
        ENCOUNTERED BY THE PROGRAM AND THE ACCEPTABLE MOVES FROM THEM
        ARE STORED IN P$(I%)
4 ! WHEN THE PROGRAM ENCOUNTERS AN UNFAMILIAR POSITION, THE POSITION
        AND ALL LEGAL MOVES FROM IT ARE ADDED TO THE LIST.
5 ! IF THE PROGRAM LOSES A GAME, IT ERASES THE MOVE THAT LED TO DEFEAT.
        IF IT HITS A POSITION FROM WHICH ALL MOVES HAVE BEEN DELETED
        ( THEY ALL LED TO DEFEAT ), IT ERASES THE MOVE THAT GOT
        IT HERE AND RESIGNS.
10 INPUT "INSTRUCTIONS"; C$: IF LEFT(C$,1%)<>"Y" THEN 110
20 &: &,"THIS PROGRAM PLAYS THE GAME OF HEXAPAWN.":&
"HEXAPAWN IS PLAYED WITH CHESS PAWNS ON A 3 BY 3 BOARD. THE PAWNS ARE":&
"MOVED AS IN CHESS - ONE SPACE FORWARD TO AN EMPTY SPACE OR ONE SPACE"
30 &"FORWARD AND DIAGONALLY TO CAPTURE AN OPPOSING MAN.":&:&CHR$(9%);
"O THE BOARD, YOUR PAWNS ARE 'O', THE COMPUTER'S PAWNS ARE '*'":&
"AND EMPTY SQUARES ARE '-'. TO ENTER A MOVE, TYPE THE NUMBER OF THE"
40 &"SQUARE YOU WILL MOVE FROM FOLLOWED BY THE NUMBER OF THE SQUARE":&
"YOU WILL MOVE TO. (THE NUMBERS ARE SEPARATED BY A COMMA.)":&
50 &"    THE PROGRAM STARTS A SERIS OF GAMES KNOWING ONLY WHEN THE":&
"GAME IS WON (A DRAW IS IMPOSSIBLE) AND HOW TO MOVE. IT HAS NO":&
"STRATEGY AT FIRST AND JUST MOVES RANDOMLY. HOWEVER, IT LEARNS"
60 &"FROM EACH GAME. THUS, DEFEATING IT BECOMES MORE AND MORE":&
"DIFFICULT. ALSO, TO HELP OFFSET YOUR INITIAL ADVANTAGE, YOU WILL":&
"NOT BE TOLD HOW TO WIN THE GAME BUT MUST LEARN THIS BY PLAYING":&
100 DEF FNC$(X$,X%,Y$)=LEFT(X$,X%-1%)+Y$+RIGHT(X$,X%+LEN(Y$))
105 DEF FNN$(X%): X$=NUM$(X%): FNN$=MID(X$,2%,LEN(X$)-2%): FNEND
110 DIM P$(50%): RANDOMIZE: Q%=0%:
        PRINT "SINCE I'M A GOOD SPORT, YOU'LL ALWAYS GO FIRST
120 P%=0%: P$="***---OOO": &: &"NUMBERING:":
        &"123": &"456": &"789": &
190 D%=-1%: Q$="O": GOSUB 2000: IF M$="" THEN
        PRINT "YOU CAN'T MOVE. I WIN.": GOTO 510
200 &: &"BOARD:": &LEFT(P$,3%): &MID(P$,4%,3%): &RIGHT(P$,7%): &
210 INPUT "WHAT IS YOUR MOVE"; A%,B%:
        IF INSTR(1%,M$,FNN$(A%)+FNN$(B%))=0% THEN
        PRINT "ILLEGAL MOVE.": GOTO 210
230 P$=FNC$(FNC$(P$,A%,"-"),B%,"O"):
        IF INSTR(1%,P$,"*")=0% OR INSTR(1%,P$,"O")<4% THEN
        PRINT "YOU WIN.": GOTO 500
300 P%=P%+2% !            COMPUTER'S MOVE
310 FOR C%=1% TO Q%: C$=P$(C%): IF VAL(LEFT(C$,1%))=P% AND
        MID(C$,2%,9%)=P$ THEN M$=RIGHT(C$,11%): GOTO 400
320 NEXT C%: Q$="*": D%=1%: GOSUB 2000: C%=Q%:
        IF M$="" THEN PRINT "I CAN'T MOVE, YOU WIN.": GOTO 500
400 IF M$="" THEN PRINT "I RESIGN.": GOTO 500
410 K$=LEFT(M$,2%): M$=RIGHT(M$,3%):
        IF RND>.33333333 AND M$<>"" THEN 410
420 K%=C%: A%=VAL(LEFT(K$,1%)): B%=VAL(RIGHT(K$,2%)):
        P$=FNC$(FNC$(P$,A%,"-"),B%,"*")
430 IF INSTR(1%,P$,"O")=0% OR INSTR(7%,P$,"*") THEN
        PRINT "I WIN!": GOTO 510
440 PRINT "I MOVE FROM" A% "TO" B%: GOTO 190
500 W2%=W2%+1%: I%=INSTR(11%,P$(K%),K$):
        P$(K%)=LEFT(P$(K%),I%-1%)+RIGHT(P$(K%),I%+2%) IF I%: GOTO 520
510 W1%=W1%+1%
520 &: &"BOARD:": &LEFT(P$,3%): &MID(P$,4%,3%): &RIGHT(P$,7%): &:
        & "I HAVE WON" W1% "AND YOU HAVE WON" W2% "OF" W1%+W2% "GAMES"
530 INPUT "ANOTHER GAME"; C$: IF C$="NO" THEN 9999 ELSE 120
900 ! DATA**= <- OF MOVE IN GAME><POSITION><LIST OF MOVES>
        IN <POSITION>, -=BLANK, *=COMPUTER'S PAWN, O=PLAYER'S PAWN
        <LIST OF MOVES> IS <- MOVE FROM><- MOVE TO><LIST OF MOVES>
2000 M$=""
2010 FOR J%=1% TO 9%: IF MID(P$,J%,1%)<>Q$ THEN 2050
2015 T%=J%+D%*3%: IF T%<1% OR T%>9% THEN 2025
2020 IF MID(P$,T%,1%)="-" THEN
        M$=M$+FNN$(J%)+FNN$(T%)
2025 T%=J%+D%*2%: IF T%<1% OR T%>9% OR
        (D%=1% AND (J%=1% OR J%=4% OR J%=7%)) OR
        (D%=-1% AND (J%=3% OR J%=6% OR J%=9%)) THEN 2035
2030 IF INSTR(1%,Q$+"-",MID(P$,T%,1%))=0% THEN
        M$=M$+FNN$(J%)+FNN$(T%)
2035 T%=J%+D%*4%: IF T%<1% OR T%>9% OR J%=3% OR J%=7% THEN 2050
2040 IF INSTR(1%,Q$+"-",MID(P$,T%,1%))=0% THEN
        M$=M$+FNN$(J%)+FNN$(T%)
2050 NEXT J%: IF D%=1% AND M$<>"" THEN Q%=Q%+1%: P$(Q%)=FNN$(P%)+P$+M$
2060 RETURN
9999 END
```

SAMPLE RUN

```
INSTRUCTIONS? Y

               THIS PROGRAM PLAYS THE GAME OF HEXAPAWN.
HEXAPAWN IS PLAYED WITH CHESS PAWNS ON A 3 BY 3 BOARD. THE PAWNS ARE
MOVED AS IN CHESS - ONE SPACE FORWARD TO AN EMPTY SPACE OR ONE SPACE
FORWARD AND DIAGONALLY TO CAPTURE AN OPPOSING MAN.

        ON THE BOARD, YOUR PAWNS ARE 'O', THE COMPUTER'S PAWNS ARE '*'
AND EMPTY SQUARES ARE '-'. TO ENTER A MOVE, TYPE THE NUMBER OF THE
SQUARE YOU WILL MOVE FROM FOLLOWED BY THE NUMBER OF THE SQUARE
YOU WILL MOVE TO. (THE NUMBERS ARE SEPARATED BY A COMMA.)

        THE PROGRAM STARTS A SERIES OF GAMES KNOWING ONLY WHEN THE
GAME IS WON (A DRAW IS IMPOSSIBLE) AND HOW TO MOVE. IT HAS NO
STRATEGY AT FIRST AND JUST MOVES RANDOMLY. HOWEVER, IT LEARNS
FROM EACH GAME. THUS, DEFEATING IT BECOMES MORE AND MORE
DIFFICULT. ALSO, TO HELP OFFSET YOUR INITIAL ADVANTAGE, YOU WILL
NOT BE TOLD HOW TO WIN THE GAME BUT MUST LEARN THIS BY PLAYING

SINCE I'M A GOOD SPORT, YOU'LL ALWAYS GO FIRST.
```

```
NUMBERING:
123
456
789


BOARD:
***
---
OOO

WHAT IS YOUR MOVE? 8,5
I MOVE FROM 1 TO 4

BOARD:
-**
*O-
O-O

WHAT IS YOUR MOVE? 5,3
YOU WIN.

BOARD:
-*O
*--
O-O

I HAVE WON 0 AND YOU HAVE WON 1 OF 1 GAMES
ANOTHER GAME?




NUMBERING:
123
456
789


BOARD:
***
---
OOO

WHAT IS YOUR MOVE? 8,5
I MOVE FROM 3 TO 5

BOARD:
**-
-*-
O-O

WHAT IS YOUR MOVE? 9,5
I MOVE FROM 1 TO 4
YOU CAN'T MOVE. I WIN.

BOARD:
-*-
*O-
O--

I HAVE WON 1 AND YOU HAVE WON 3 OF 4 GAMES
ANOTHER GAME?




NUMBERING:
123
456
789


BOARD:
***
---
OOO

WHAT IS YOUR MOVE? 8,5
I MOVE FROM 1 TO 5

BOARD:
-**
-*-
O-O

WHAT IS YOUR MOVE? 9,5
I MOVE FROM 3 TO 6

BOARD:
-*-
-O*
O--

WHAT IS YOUR MOVE? 7,4
I WIN!

BOARD:
-*-
OO-
--*

I HAVE WON 3 AND YOU HAVE WON 5 OF 8 GAMES
ANOTHER GAME? NO

READY
```

TAC TIX

TAC TIX is an ideal game to program for the computer. The program may be written in two ways:

1. Program the computer to play TAC TIX in a rigorous way. To do this, you must determine mathematically the optimum playing strategy and then express that strategy as a general algorithm.
2. Program the computer to play TAC TIX in a cybernetic way. Using this method, the program starts only by knowing the rules of the game. It is programmed to "remember" and use the moves that result in a victory, and to "forget" and not use the moves that result in defeat. Using this programming technique, the computer should learn the optimum strategy in about 12 or 16 games.

The original problem as printed below was written by Raymond E. Spaulding, Radford College, Virginia, and appeared in *The Mathematics Teacher,* November, 1973. A free *101 BASIC Computer Games* book goes to the best BASIC version of TAC TIX received by May 1, 1974. Send your solutions to: TAC TIX, Education Products Group, Bldg. 5-5, DIGITAL.

Rules

At the start of each contest, twenty-five markers are placed in the cells of a 5 X 5 grid (see Figure 1). Play then proceeds according to the following simple rules:

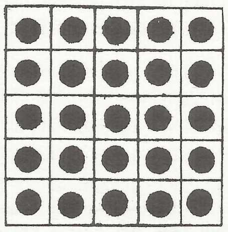


Figure 1

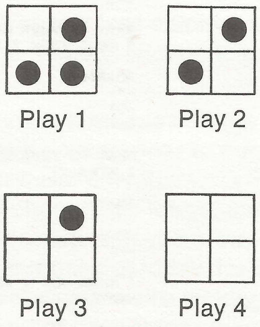


Figure 2

1. Players alternate in taking turns.
2. During a turn, a player may take as many markers as he wishes from any one row (or column) provided that the markers are in adjacent cells.
3. At least one marker must be taken during a turn.
4. The player taking the last marker wins.

Comments

The game of TAC TIX has a winning strategy. One sensible search for the strategy begins with simplification. Can we find a simpler game related to this game and having an easily identified winning strategy?

To simplify this game, try a 2 X 2 grid. One sample game might go as in Figure 2, with Player 2 (P2) winning. Player 1 P(1) wins the contest shown in Figure 3 with a 3 X 3 board.

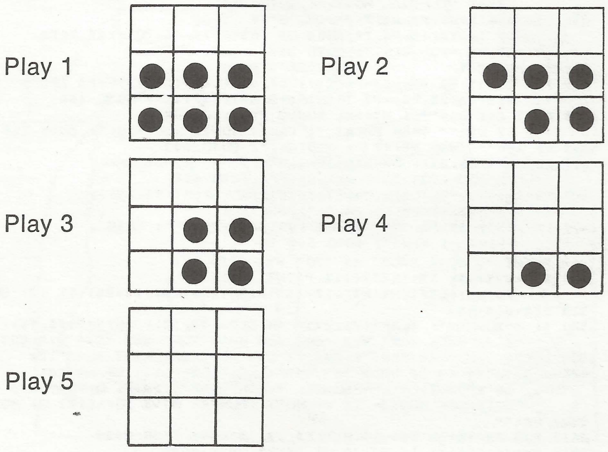


Figure 3

Extensions

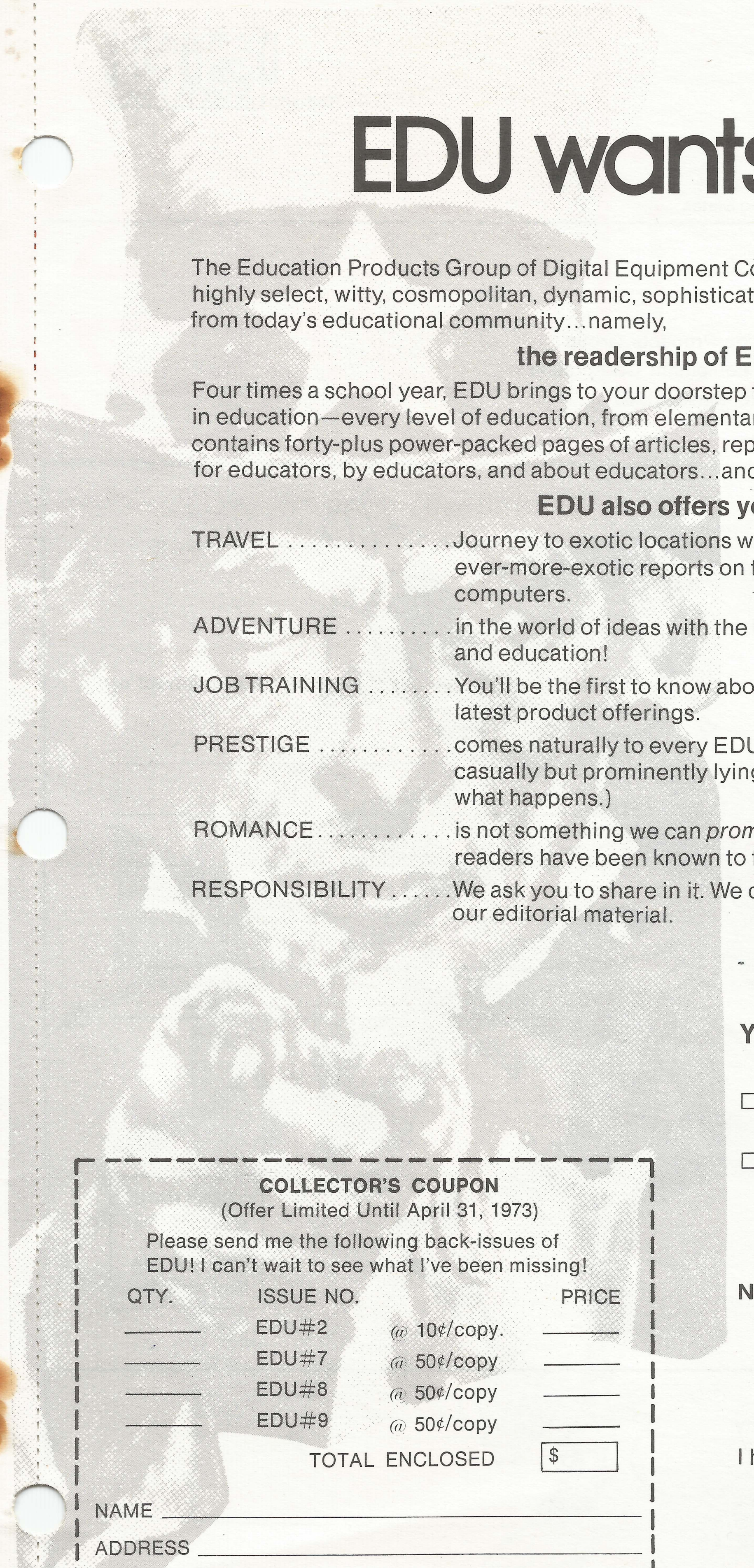
The game of TAC TIX can be changed in several ways to create new and interesting games. If the playing board is an *n X m* rectangle, what is the winning strategy? If rule 4 is changed to make the player taking the last marker the loser, what happens to the winning strategy?

A game related to TAC TIX is played on the 8 X 8 chessboard. Each player is given eight pieces to play in turn; each piece is a square that will cover four cells of the chessboard. During a turn, a player places one of his pieces on the chessboard covering four cells. The player who plays the last possible piece wins. Can you devise a winning strategy for this game.

REFERENCES

Gardner, Martin. *Mathematical Puzzles and Diversions.* New York: Simon and Schuster, 1959.

Gardner, Martin. *Martin Gardner's New Mathematical Diversions from Scientific American.* New York: Simon and Schuster, 1966.



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